(a) the Florida Reef Tract is declining;

(b) both natural and anthropogenic factors are responsible for the decline; and

(c) adequate data are not available to document the extent of the problem and the specific natural and man-induced factors responsible for the decline.

The summary of findings and current problems presented in the Coral Community Assessment (CSA, 1991) are as follows:

"Factors that influence the health of the Florida Keys' reefs can be separated into two categories: natural and man-induced. Natural parameters include biological competition and predation, disease, light, temperature, salinity and storms. Man-induced factors are nutrient enrichment, sedimentation, turbidity, pesticides and PCGs, hydrocarbons, heavy metals, and freshwater. Despite being able to identify most of these factors, understanding the mechanisms is difficult because of the many different interactions between various parameters and the diverse ways in which they affect specific areas. Further confounding the problem is the fact that the Florida Reef Tract is already living at the climatic threshold for a coral reef and any additional changes in the environment could cause major impacts on the community.

There is a general consensus among researchers that both natural and anthropogenic factors are affecting the coral community of the FKNMS. Although there appears to be a severe problem, there are not sufficient baseline and research data available from most locations to scientifically document the extent of the problem. Since what constitutes natural conditions is in many cases unknown, discerning natural changes from anthropogenic perturbations is extremely difficult. The workshop on Coral Bleaching, Coral Reef Ecosystems, and Global Climate Change was held in Miami in June 1991 (D'Elia et al., 1991). A major conclusion of the workshop was that 'much subjective evidence exists to indicate that there is a worldwide decline in the overall health of coral reefs and related ecosystems, but there are not adequate baseline and survey data to provide a vigorous scientific assessment of the nature and extent of the problem'.

Specific coral reef problems documented by researchers in the Florida Keys include the...blue-green algal bloom off Key Largo on which suspected nutrient enrichment is causing the algae to overrun and kill the octocoral community on this reef. Black-band disease has also been reported as prominent at this location. Additionally, a similar problem exists with the Codium isthmocladum bloom farther to the north off the southeast Florida coast. A bloom of the alga Dictyota sp. occurred in the summer of 1990 off Sand Key near Key West where there also is an increase in the incidence of black-band disease. There appears to be a general consensus among researchers that algal growth throughout the Keys is increasing.

Dustan and Halas (1987) documented significant changes between 1974 and 1982 in the hard coral community of Carysfort Reef. They used repetitive line transects to measure the individual colonies along the transects to determine changes in the mean colony size, abundance, and cover They found the community had changed significantly over 8 years,

with corals increasing in abundance in the shallow reef areas and decreasing in abundance on the deeper fore reef.

Porter (in preparation) during surveys of reefs at Looe Key and Key Largo, detected a 4% loss in coral cover per year between 1984 and 1986. Soon-to-be published data indicate that this loss in coral cover has increased since 1986 (J. Porter, University of Georgia, personal communication, 1991). Additional quantitative surveys are currently being undertaken by Porter at reefs in the Biscayne National Park."

Direct damage to coral reefs caused by human activities is not specifically addressed in the Coral Assessment (CSA, 1991). Damage to corals is widespread throughout the Keys due to the high level of recreational activity, estimated at over one million users annually (Miller, 1988). Researchers recognize direct damage to coral reefs associated with recreational activities as a significant threat (J. Porter, University of Georgia, personal communication, 1991; NOAA, 1988; NOAA and RSMAS, 1991).

D. Potential for Conservation, Use or Protection of Coral Communities

The Florida Keys National Marine Sanctuary (FKNMS) Management Plan will provide the basis for future federal, state and local conservation activities affecting the resources of the Sanctuary, including its coral communities. The Plan will identify the regulatory strategies and alternative institutional responsibilities for resource protection. It will include a plan for public education regarding coral conservation, as well as recommendations for a coral research program.

As part of the FKNMS Management Plan, the FKNMS Water Quality Protection Program (see Section 3.5.4 A and B above) will:

(a) adopt or revise water quality standards to assure protection of coral reefs;

(b) adopt pollution control measures and methods to eliminate or reduce pollution from point and non-point sources, including those which are found through future research to affect coral reefs; and

(c) establish a comprehensive water quality monitoring program.

The Monroe County Department of Marine Resources will be responsible for implementing regulations and management guidelines at the FKNMS Management Plan and FKNMS Water Quality Protection Program at the local level. This will be undertaken through a memorandum of agreement with NOAA, EPA, SFWD and DER, to be executed upon adoption of the FKNMS Management Plan and the FKNMS Water Quality Protection Plan.

The County's role in activities in offshore waters which directly affect coral communities will be minor, as these are generally not within the County's jurisdiction. The County anticipates supporting the coral community research program and the public education program regarding coral community conservation. The most significant opportunity for the County to participate in the effort to conserve the coral communities of the Keys will be to implement the water quality protection policies,

programs, and regulations of the Comprehensive Plan and the FKNMS Water Quality Protection Program. These activities are discussed above in Section 3.5.4.F.

3.9 Wetlands

The biological communities of the Florida Keys include five wetland types which provide important storm protection, water quality protection, and wildlife habitat functions. These wetland communities include:

(a) mangrove forests along the shorelines of the Keys;

(b) transitional wetlands lying landward of the mangrove fringe and seaward of upland communities;

(c) salt ponds occupying shallow enclosed basins having very restricted tidal influence;

(a) beaches; and

(b) small freshwater wetlands and freshwater ponds in areas of freshwater lenses in the Lower Keys.

"Disturbed wetlands" occur throughout the Keys. In the Keys, disturbed wetlands are generally wetlands which were originally characterized by salt marsh and buttonwood, or mangroves.

The Comprehensive Plan Map Atlas includes Natural Features Maps showing areas within the Upper, Middle and Lower Keys and selected offshore islands which are characterized by mangrove forests, undisturbed salt marsh and buttonwood wetlands, salt ponds and freshwater wetlands. (Disturbed wetlands are not mapped.) These maps are available at a scale of 1"=2,000' and can be reviewed at the Monroe County Department of Planning.

By September 30, 1993, Monroe County expects to replace its existing wetlands maps with detailed wetlands mapping prepared through the ADID Program, utilizing a geographic information system (GIS) (see Section 3.9.2 below).

3.9.1 Wetlands Permitting and the Need for Wetlands Protection Planning in Monroe County

Monroe County currently does not have a "no net loss" of wetlands policy. There is very little wetlands planning and permitting is done on a site-by-site basis (Monroe County Department of Environmental Resources, 1991). This has resulted in a somewhat piecemeal approach to lessening development impacts in wetlands communities.

Generally wetlands permitting activity in the Keys is greatest within areas of pervious alteration, or disturbed wetlands. During the "subdivision boom" of the 1940's and 1950's, an unknown amount of Florida Keys wetlands and submerged lands were lost to dredge and fill creation of new subdivisions. Since that time, the vacant lots in many of these subdivisions have begun to succeed back to some type of wetland community. While most of the areas classified as wetlands in the

Florida Keys will fit into the five basic types of communities listed above, the degree to which they have been altered has had an effect on the functional value of each wetland. Historically, the County has made a simple distinction between disturbed and non-disturbed wetlands, according to the following definition (Monroe County BOCC, 1990):

> "manifest signs of environmental disturbance which has had an observable effect on the structure and function of the natural community which existed on the site prior to the disturbance"

Functional or habitat analysis has never been performed for Keys' wetlands. Compensatory or mitigative actions required of a developer or landowner who fills wetlands consists of minimizing impacts where posssible. These requirements are set by design criteria for salt marsh, disturbed salt marsh, mangrove, freshwater wetlands, and submerged land (salt ponds) in the Monroe County Land Development Regulations (LDR's) (Monroe County BOCC, 1990). Site coverage is limited by open space requirements for each habitat type. (See Sections 3.9.3 through 3.9.8 for a specific discussion of LDR's pertaining to specific wetland habitat types.)

The County uses current FDOT aerial photographs (1"=200') for preliminary assessment of property. However, conditions depicted on these aerials are always verified by on-site inspection.

3.9.2 Monroe County Advance Identification of Wetlands (ADID) Program

Detailed mapping of wetlands (including disturbed wetlands) in the Florida Keys is now underway through a joint program of the EPA and COE, in cooperation with the FWS, SFWMD, FGFWFC, and Monroe County. This program, known as the Florida Keys Advance Identification of Wetlands Program (ADID), will inventory and map wetlands in the Keys utilizing a Geographic Information System (GIS), prioritized as follows:

(a) privately-owned lands with development potential on the islands connected by US 1;

(b) publicly-owned lands on the islands connected by US 1; and

(c) offshore islands (which appear in imagery of the islands connected by US 1).

Participants in the ADID Program will work cooperatively to:

(a) develop a wetlands functional assessment protocol for the Florida Keys (to be based upon habitat suitability, water quality and flood flow alteration functions of marine and freshwater wetlands);

(b) complete a functional analysis of all wetlands within Improved Subdivisions and of selected sites outside Improved Subdivisions, according to statistically valid selected sample locations for each wetland vegetative cover type;

(c) ground-truth the wetland vegetative cover maps using a differential global positioning system; and

(d) revise wetland vegetative cover data to reflect groundtruthing results.

Upon completion of these activities, a new composite map set showing wetlands of the Florida Keys will be plotted by the GIS at a scale of 1"=200'. These maps will replace existing 1"=2,000' scale wetlands maps used by the Monroe County Department of Planning. They are scheduled to be completed by September 30, 1993.

Results of the functional analysis will be used to develop and implement a policy of "no net loss" of the functional value of disturbed wetlands. The County expects to revise as appropriate the Monroe County Land Development Regulations (Monroe County BOCC, 1990) pertaining to disturbed wetlands.

3.9.3 Mangrove Communities

Mangrove wetland communities are addressed above in Section 3.8.1 of the Living Marine Resources Section. Included are discussions of the following:

(a) flora of mangrove communities;

(b) existing commercial, recreational and conservation uses of mangrove communities;

(c) known pollution problems and/or issues related to mangrove communities; and

(d) potential for conservation, use or protection of mangrove communities.

3.9.4 Salt Marsh and Buttonwood Wetlands

Saltmarsh and buttonwood wetlands are tidally influenced transitional wetlands which lie landward of the mangrove fringe and seaward of the upland community. Two basic wetland communities occur in the transition zone in the Florida Keys. Salt marshes are the lower transitional wetlands. Buttonwood (Conocarpus erectus) associations are generally higher transitional wetlands, occurring between the salt marshes and the high upland habitats.

The type of transitional association that develops in the Keys is a function of tide and topography. In the Lower Keys, where the slope of the intertidal zone is very slight, the broadest expanse of transitional zones occur. On Sugarloaf, Cudjoe, Big Torch, Little Torch and on a number of other keys, transitional zones occupy areas hundreds of feet in width. On these keys, much of the eroded oolitic caprock is exposed, creating a karst-like substrate with disjunct, shallow depressions containing marl soils. Most of these areas are wetted only by the highest normal tides and by storm tides.
By comparison, in the Middle and Upper Keys, there is a relatively steep slope to the high ground, which is elevated above normal tidal influence. In these areas the transitional zone is quite narrow, with hammock often found within a short horizontal distance from the high water mark.

As of 1990, the Florida Keys are estimated to have approximately 6,500 acres of undisturbed salt marsh and buttonwoods. Of these, approximately 2,000 acres are owned by state and federal agencies and 4,500 acres are privately-owned. In addition, there is an undocumented area of salt

marsh and buttonwood wetlands which have been disturbed by various human activities such that there has been an observable effect on the structure and function of the natural wetland community. Disruptive activities include: placement of dredge spoils; clearing of vegetation; impoundments; drainage of surface waters; blockage of surface drainage; restriction of tidal circulation; introduction of invasive plants; and dredging. The ADID Program (see above) will locate salt marsh and buttonwood wetlands, calculate their areal extent, and assess the functional value of individual wetland parcels.

A. Flora of Salt Marsh and Buttonwood Wetlands

Flora of Undisturbed Salt Marsh and Buttonwood Wetlands

Several environmental factors control species distribution in transitional wetlands. These are functions of tidal influence and are linearly related to distance from mean high water. They include: (a) duration of tidal submergence; (2) duration of exposure; and (c) frequency of submergence. Because of the low tidal amplitude (3 feet) in the Keys, the inundation of the transition zone may be affected by several other factors, including wind direction and velocity, shoreline exposure, slope, elevation and microrelief. As a result, the position of an individual plant population within the transitional zone reflects an adaptive response to a complex set of environmental gradients.

The transitional habitats of the Keys contain species representative of both the adjacent mangrove and upland communities. In the most seaward subzone of transitional areas scrub mangrove communities typically occur. These are dominated by small Red and Black Mangroves with an understory of Glasswort (Salicornia spp.), Salt Grass (Distichilis spicata), Key Grass (Monanthochloe littoralis) and Sea Daisy (Distichilis spicata). Moving upland, there is a change to a more diverse plant community with fewer mangroves. Depending on drainage and soil conditions, this association can be either buttonwood scrub or salt marsh.

Salt marshes, distinguished from adjacent associations by their low stature and lack of wood vegetation, are dominated by salt-tolerant herbs, shrubs and grasses. Some salt marshes are mixtures of fleshy halophytes, including Glasswort (Salicornia virginica and S. bigelowii), Purslane (Sesuvium portulacastrum) and Saltwort (Batis maritima) with occasional Sea Daisy and small mangroves. Other marshes are dominated by grasses, including Salt Grass, Key Grass, and Dropseed, and occasional Fimbristylis castanea, Sea Daisy, Saltwort, Buttonwood and small mangrove. These graminoids and herbs occur as small, disjunct populations forming a mosaic. In some cases a single population will occupy an area of about a half acre, whereas in others, the same species might be represented by only a few individuals. This distributional variability probably reflects the area's microrelief, which determines drainage and soil salinity.

The most landward subzone generally contains the most diverse flora because of its proximity to rich upland hammocks. Buttonwood becomes abundant and is generally associated with an understory of Sea Daisy, Dropseed, Sea Oxeye (Borrichia arborescens), Cordgrass, Chestnut Sedge, Christmas Berry (Lycium carolinanum) and other small shrubs, herbs and graminoids. The open aspect of the association, resulting from the branching habit of the buttonwoods, allows sunlight to reach the ground and generates abundant vegetation beneath the trees, where is typically soil accumulation. The bromeliad Tillandsia circinata is a frequent epiphyte on the buttonwoods. The Wild Allamanda (Urechites lutea) and Rubber Vine Rhabdadenia biflora) are also often found on buttonwoods

Moving upland, the transitional zone grades into hammock. The landward extent of the tides is marked by the accumulation of litter on the forest floor and generally corresponds to the hammock boundary. Often, there are small areas of low hammock within the transitional zone vegetated by small, salt tolerant trees and shrubs.

Flora of Disturbed Salt Marsh and Buttonwood Wetlands

Vegetation of disturbed salt marsh and buttonwood communities may be either a remnant of what existed prior to the disturbance or what has colonized the site after the disturbance. Areas of disturbance which are wetted by spring or storm tides, but do not contain poorly drained, saturated soils, are often vegetated by dense stands of small buttonwoods with an understory of sea daisy and salt tolerant graminoids. Individual trees remain small relative to the stature of buttonwoods growing in undisturbed conditions. Disturbed areas which are only partially vegetated by buttonwood, but still contain open zones, are highly susceptible for colonization by invasive plants, such as Schinus and Australian pine.

B. Existing Commercial, Recreational or Conservation Uses of Salt Marsh and Buttonwood Wetlands

Uses in Undisturbed Salt Marsh and Buttonwood Wetlands on Private Lands

Single family residential development is the primary developed use which is currently found and permitted in salt marsh and buttonwood wetlands in Monroe County. Undisturbed salt marsh and buttonwood wetlands are generally located within the "Sparsely Settled," "Native Area," and Suburban Residential" land use districts (Monroe County BOCC, 1990). Section 9.5-262 of the Monroe County Land Development Regulations (LDR's) (Monroe County BOCC, 1990) allows densities of 0.5, 0.3, and 1.0 units per buildable acre. Section 9.5-343 establishes an open space requirement of 85 percent for undisturbed salt marsh and buttonwood wetlands.

Section 9.5-345(b) of the LDR's (Monroe County BOCC, 1990) provides protection to undisturbed salt marsh and buttonwood wetlands by restricting fill to a maximum of 4,000 square feet or 7.5 percent of the total area of salt marsh and buttonwood wetlands, whichever is greater. Filling is subject to further restrictions designed to minimize impacts on adjacent wetlands and habitat areas. Roads and structures cannot disturb natural drainage patterns. Wastewater must be treated by a waterless toilet or by an OSDS which is located in or discharges into upland area.

DER regulates placement of fill in salt marsh and buttonwood wetlands subject to Chapter 17-312, F.A.C., title "Additional Criteria for Dredging and Filling with Outstanding Florida Waters in Monroe County." Permits are issued on a case-by-case basis for placement of fill in salt marsh and buttonwood wetlands in instances where the activity is "in the public interest" and where adequate mitigation can be accomplished.

Other agencies which may have jurisdiction in salt marsh and buttonwood wetlands, depending upon the size and location of the wetland and the possible presence of protected species, include the COE, SFWMD, FGFWFC, and FWS. HRS may consider wetlands when permitting sewage disposal systems and, in some cases, may prohibit on-site disposal systems.

Uses in Disturbed Salt Marsh and Buttonwood Wetlands on Private Lands

Disturbed salt marsh and buttonwood wetlands in Monroe County generally occur on disturbed residential lots in Improved Subdivision (IS), Commercial Fishing Village (CFV), and Urban Residential Mobile Home (URM) zoning districts. Generally one house is permitted per lot in these districts. Section 9.5-343 of the LDR's (Monroe County BOCC, 1990) establishes an open space requirement of 20 percent for disturbed salt marsh and buttonwood wetlands.

Section 9-5-345(o)(4) of the LDR's (Monroe County BOCC, 1990) provides protection to disturbed salt marsh and buttonwood wetlands by prohibiting disturbances to natural drainage patterns by roads and accessways, and by requiring wastewater treatment using a waterless toilet or by OSDS that is located in or discharges into an upland habitat area.

Permitting procedures for placement of fill in disturbed salt marsh and buttonwood wetlands are similar to those described in the previous section for undisturbed salt marsh and buttonwood wetlands.

Salt Marsh and Buttonwood Wetlands in Conservation Lands

Approximately 2,000 acres of undisturbed salt marsh and buttonwood wetlands are owned by state and federal agencies and presumably will not be disturbed. Conservation lands (see Section 3.18) in the Florida Keys which encompass large tracts of salt marsh and buttonwood wetlands include:

National Key Deer Refuge;
Great White Heron National Wildlife Refuge;
Key West National Wildlife Refuge;
Crocodile Lake National Wildlife Refuge;
John Pennekamp Coral Reef State Park;
Lignumvitae Key Aquatic Preserve;
Biscayne Bay-Card Sound Aquatic Preserve;
Coupon Bight Aquatic Preserve; and
Coupon Bight/Key Deer CARL Project.

Disturbed salt marsh and buttonwood wetlands in public ownership on conservation lands (see Section 3.18) are few and widely scattered.

C. Known Pollution Problems and/or Issues Related to Salt Marsh and Buttonwood Wetlands

Placement of fill for residential development, accessory structures, and accessways is the primary source of pollution in salt marsh and buttonwood wetlands in the Keys. Placement of fill disrupts the local natural drainage pattern, thereby affecting adjacent wetland areas outside of the immediate area of filling. Homeowners typically introduce non-native plant material in residential landscaping and, with time, expand the area of disturbance further into adjacent wetlands. On-site disposal systems serving development sites in salt marsh and buttonwood wetlands are likely to function improperly due to soil wetness and flooding. Malfunctioning systems release nutrients and other contaminants into the substrate and the highly permeable underlying limestone. From there the contaminants move laterally in groundwater to adjacent wetlands and nearshore waters.

Assuming the worst case, Monroe County's current LDR's would allow construction of as many as 2,250 dwelling units in the remaining undisturbed salt marsh and buttonwood wetlands of the Keys (Monroe County BOCC, 1991a). This development could have associated with it disturbance of up to 15 percent of the total remaining undisturbed wetland area, representing a potential loss of wetland habitat of as much as 675 acres. In actuality, the area of impact is likely to be significantly greater than 675 acres due to the indirect impacts of development, such as alteration of tidal flow, OSDS contamination of groundwater, introduction of invasive plants, and residential activities which expand into adjacent undisturbed wetlands.

Development potential for disturbed salt marsh and buttonwood wetlands and its associated impacts are addressed in Section 3.9.8.B below.

Other pollution problems and concerns related to salt marsh and buttonwood wetlands include:

(a) illegal dumping;

(b) damage from off-road vehicles; and

(c) disruptive activities at the fringe of salt ponds caused by the proximity to developed land uses.

Illegal dumping is a problem along the perimeter of and within salt marsh and buttonwood wetlands, particularly where there is vehicular access. This is of special concern due to the potential dumping of uncontained hazardous wastes which can leach into the soil and enter groundwater.

Due to ease of access many areas of salt marsh and buttonwood wetlands in the Keys also suffer disturbances from off-road vehicles and heavy equipment. Salt marsh plants have shallow root systems that form a rhizosphere only a few inches below the soil surface. Shallow marl soils tend to compress under loads. As a result, persistent tracks are easily formed by vehicles where vegetation has been killed and soil conditions are unfavorable for recolonization of wetland plants.

Close proximity of developed land uses to salt marsh tends to adversely affect perimeter areas of the wetland. These impacts are typically direct physical effects caused by landowner dumping of yard debris at the perimeter of residential lots and the cumulative impacts of homeowners through the years caused by yard improvements, such as perimeter clearing, minor spot filling, and planting of non-native plant materials.

D. Potential for Conservation, Use or Protection of Salt Marsh and Buttonwood Wetlands

In general, federal, state and local governments have found the impacts of development on productive wetlands to be unacceptable. Monroe County currently limits disturbance of undisturbed salt marsh and buttonwood wetlands to 15 percent of the site area. Despite this limitation, valuable wetland communities are being lost to development. The potential loss of an additional 675 acres of these wetlands (see above) constitutes a significant potential impact on the natural systems of the Keys, particularly on wildlife and nearshore water quality. Appropriate action would be to establish a 100 percent open space requirement for the remaining undisturbed salt marsh and buttonwood wetlands throughout the Keys, thereby eliminating future losses of this type. Retention of existing

allocated density pursuant to Section 9.5-262 of the LDR's would allow for continued development value in these areas without permitting their disturbance.

Upon completion of the functional assessment of wetlands in the ADID Program (see Section 3.9.2 above) Monroe County should revise its permitting regulations pertaining to placement of fill in disturbed salt marsh and buttonwood wetlands to require "no net loss" of functional value (see Section 3.9.8 below).

Off-road vehicle trespassing onto salt marsh and buttonwood wetlands could be reduced through improved posting of private lands and by stepped-up enforcement of trespass laws and illegal use of public lands by the Environmental Crimes Task Force.

Illegal dumping in Monroe County, including dumping in salt marsh and buttonwood wetlands, could be reduced through "neighborhood pick-up days" during which the County removes clean residential solid waste free-of-charge. Stepped-up enforcement of existing dumping regulations by the Environmental Crimes Task Force could also reduce illegal dumping.

In order to better protect salt marsh and buttonwood wetlands from the impacts of man's activities on adjacent lands, the Land Development Regulations should be revised to require minimum vegetated setbacks from wetlands for adjacent upland development. Regulations should restrict land development, such as placement of structures and on-site disposal systems, as well as homeowner activities.

3.9.5 Beaches

Beaches are addressed below in Section 3.10. Included are discussions of the following:

a) beaches of the Florida Keys;

b) flora of beach communities;

c) existing commercial, recreational and conservation uses of beaches;

d) known pollution problems and/or issues related to beaches;

e) past trends in beach erosion and accretion;

f) effects of coastal or shore protection structures on beaches;

g) existing and potential beach renourishment areas; and

h) potential for conservation, use or protection of beaches.

3.9.6 Salt Ponds

Salt ponds are remnants of former open water areas that have been cut off from tidal connection by storm-built berms or man-made structures. This result is a shallow impoundment which receives saltwater during intense storm events and rainwater on a regular, seasonal basis.

Salt ponds occur throughout the Keys. They range in size from less than one acre to tens of acres. The best known are located in Key West, Cudjoe Key, Little Torch Key and Long Key. Seasonally variable water depths range from 2 feet to occasionally dry in the late spring. Salinity of pond waters has been measured at 6 ppt to 66.3 ppt. Sediment salinities in some ponds may be higher at the end of the dry season. Because of the typically small volume of water contained in these ponds, water temperatures approach those of the ambient air, ranging from 69.4 to 84.9 degrees F (monthly mean, Key West). In the smaller ponds, and in the large ponds during periods of dry-down, daily water temperature fluctuations are probably more extreme, with peak summer values in excess of 90 degrees F.

Salt pond sediments are generally a mixture of organic mud marl and coarser-grained, calcareous skeletal elements derived from marine organisms. These sediments often have a reddish color. Their composition reflects a history of both in situ deposition and storm deposition. In some ponds, there is only a thin (1 to 2 inches) marl layer over the caprock, whereas in others, sediment depths exceed a foot and are often anaerobic.

Although salt pond systems are subject to harsh extremes in temperature and salinity, they support a flora and fauna which can be adapted to these extremes and which, as a result of the extremes, can be continually changing.

A. Flora of Salt Ponds

Dominant salt pond plants include green algae (Batophora oerstedii) and Acetabularia crenulata on coarse substrates, and Widgeon Grass (Ruppia maritima), Spike Rush (Eleocharis cellulosa), and Shoal Grass (Halodule wrightii) rooted in the sediments. Occasional Black Mangrove (Avicennia germinans) and, less frequently, Red Mangrove (Rhizophora mangle) are found in the ponds, especially in peripheral areas. The smaller ponds often contain little or no macroscopic vegetation. In larger ponds the Spike Rush and occasional mangroves are restricted to the pond margins, while the central area usually contains no emergent vegetation.

Probably the best adapted biotic element of the salt ponds is the periphyton, an association of microalgae (primarily blue-greens) that form mat-like structures composed of fine algal filaments. In wetland areas which periodically dry out, these mats appear as black crusts on the surface of the caprock or sediment.

The seasonal fluctuations and extremes of temperature, salinity and exposure characteristic of salt ponds are inimical to the seagrasses which normally occur in shallow water bodies in the Keys. Seagrasses are usually abundant in similar areas that are regularly influenced by surface tidal flow.

B. Existing Commercial, Recreational or Conservation Uses of Salt Ponds

Uses in Salt Ponds on Private Lands

The Monroe County Land Development Regulations (LDR's) (Monroe County BOCC, 1990) classify salt ponds as "submerged lands". Non water-related uses (exclusive of utility pilings) are not permitted in submerged lands in Monroe County. Section 9.5-345 of the LDR's includes Environmental Design Criteria which specify the types of water-related and utility structures allowed. The Environmental Design Criteria which are pertinent to submerged lands lying below the mean high water line of an upland water body, are as follows (Monroe County BOCC, 1990):

(a) only piers, docks, utility pilings and walkways shall be permitted on submerged lands; and

(b) all structures on submerged lands shall be designed, located and constructed on pilings or other supports.

Conservation Lands Encompassing Salt Ponds

Salt ponds on Cudjoe Key and Little Torch Key are located within the limits of the National Key Deer Refuge, although they remain in private ownership.

C. Known Pollution Problems and/or Issues Related to Salt Ponds

Until around 1 985, salt ponds in the Florida Keys were filled routinely for purposes of providing dry land for development. The passage of the Clean Water Act effectively stopped such activities in the Keys. In 1986, Monroe County adopted its current Land Development Regulations (see above) which also prohibited these activities.

Pollution problems and other concerns related to salt ponds which remain today include:

a) illegal dumping; and

b) disruptive activities at the fringe of salt ponds caused by the proximity to developed land uses.

Illegal dumping is a problem along the perimeter of salt ponds, particularly where there is vehicular access. This is of special concern due to the potential dumping of uncontained hazardous wastes which can leach into the soil and enter groundwater.

Close proximity of developed land uses to salt ponds tends to adversely affect perimeter areas of the wetland. These impacts are typically direct physical effects caused by landowner dumping of yard debris at the perimeter of residential lots and the cumulative impacts of homeowners through the years caused by yard improvements, such as perimeter clearing, minor spot filling, and planting of non-native plant materials.

D. Potential for Conservation, Use or Protection of Salt Ponds

Illegal dumping in Monroe County, including dumping in salt ponds, could be reduced through "neighborhood pick-up days" during which the County removes clean residential solid waste free-of-charge. Stepped-up enforcement of existing dumping regulations by the Environmental Crimes Task Force could also reduce illegal dumping.

In order to better protect salt ponds from the impacts of man's activities on adjacent lands, the Land Development Regulations should be revised to require minimum vegetated setbacks from wetlands for adjacent upland development. Regulations should restrict land development, such as placement of structures and on-site disposal systems, as well as homeowner activities.

3.9.7 Freshwater Wetlands

In areas on several larger keys, freshwater infiltrating from the surface enters the groundwater table and forms freshwater lenses (see Natural Groundwater Aquifer Recharge Chapter). The size of these lenses is controlled by rainfall, freshwater discharge (seepage, pumpage, runoff, evapotranspiration), response to tidal fluctuations, proximity to saltwater bodies, permeability of the subsurface materials, and elevation of the island above sea level (Klein, 1970; Hanson, 1980).

Freshwater lenses in the Keys occur on Key West, Big Pine Key, Cudjoe Key, No Name Key, Ramrod Key and Sugarloaf Key. The largest lenses outside of Key West occur on Big Pine Key where the hydraulic conductivity in the Miami Oolite surface substrate is sufficiently low to allow for retention of fresh groundwater in two distinct Ghyben-Herzberg lenses (Hanson, 1980). Discharge from these freshwater lenses is to topographic lows. Small freshwater pools and freshwater wetlands dominated by Sawgrass (Cladium jamaicense) typically develop in these low areas. Some groundwater discharge occurs to mosquito control ditches, where freshwater wetlands dominated by Cattail (Typha spp.) typically develop. The largest and best known of the surface freshwater ponds on Big Pine Key is Blue Hole, a small (one acre) man-make lake within the boundaries of the National Key Deer Wildlife Refuge (Lapointe, 1989b).

By comparison to those on Big Pine Key, the freshwater lenses on Cudjoe Key, No Name Key, Ramrod Key and Sugarloaf Key are much smaller in size and generally do not have adequate year-round groundwater discharges to sustain large permanent freshwater pools or wetlands.

The FGFWFC is currently mapping freshwater wetlands in parts of the Keys and that project is scheduled for completion some time in 1992. The Advance Wetlands Identification Program, now underway as a joint effort by the COE, DER, SFWMD and Monroe County, will complete the mapping of freshwater wetlands. Mapped information will be entered into the GIS and plotted as an overlay at a scale of 1"=200'.

A. Flora of Freshwater Wetlands

Flora of Sawgrass Marshes

The most extensive freshwater wetlands in the Keys are the Sawgrass (Cladium jamaicensa) marshes of Big Pine Key and adjoining smaller keys. These sawgrass marshes occur along the edges of the slash pinelands, at slightly lower elevations, generally less than four feet. The occurrence of the

sawgrass marshes, as well as the pinelands conforms quite closely with the outline of the two freshwater lenses beneath Big Pine Key (Ross, 1989). The freshwater wetlands include large, natural and impounded sloughs in the central portion of Big Pine Key and numerous smaller interior basins scattered throughout Big Pine Key. The sloughs are important discharge areas that receive drainage from the freshwater lenses during periods of high water and, because of their size and extensive ditching, typically contain most of the surface freshwater on Big Pine Key at any one time (Jackson, 1989). In contrast, the smaller, interior basins are recharge areas that retain water until it can be absorbed into the ground and surrounding uplands (Jackson, 1989).

The Sawgrass Marshes are dominated by Sawgrass (Cladium jamaicensis). Other freshwater marsh species include Saw Sedge (Cyperus ligularis), White-top Sedge (Dichromen floridensis), Leather Fern (Acrostichum sp.), False Foxglove (Agalinis spp.), Aster (Aster tenuifolius), Broom Sedge (Andropogon glomeratus), and Buttonwood (Concocarpus erectus). Two vines, Mangrove Rubber Vine (Rhabdadenia biflora and Wild Allamana (Urechites lutea), as well as a variety of bromeliads, occasionally occur on the buttonwoods.

Sawgrass occurs ubiquitously in both fresh and brackish wetlands. In areas that contain brackish water or slightly saline soils, the association often includes other salt tolerant forms including Eleocharis cellulosa, and sedges Fimbristylis castanea and F. spatacea, and the grasses Sporobolus virginicus and S. domingensis. In these areas, buttonwood and mangroves also frequently occur. In small, shallow solution depression on Big Pine, No Name, Cudjoe and Sugarloaf Keys dense stands of Saw Palmetto (Serenoa repens) are found closely associated with sawgrass.

While less diverse than the pinelands with which they are typically associated, the sawgrass marshes contain several state-protected plants, including Strumpfia maritima, Jacquinia keyensis, and species of the genus Tillandsia.

Flora of Cattail Marshes

Cattail (Typha spp.) marshes occur less extensively than the Sawgrass marsh on Knockemdown, Big Pine, Little Torch, Middle Torch, Sugarloaf and Cudjoe Keys. Because cattail marshes naturally occur well within the confines of hammocks protected from the xeric atmospheric conditions characteristic of more open areas, they are probably subjected to saline influences only during hurricanes.

Where organic soils are deeper, these marshes are characterized by almost pure stands of Cattail (Typha spp.). In some, Spike Rush (Eleocharis cellulosa) often occurs in pure stands just a few inches below the Sawgrass. Buttonwoods and occasional mangroves are present on the borders, supporting mixed populations of bromeliads (Tillandsia spp.) and, in the past, orchids (Encyclia tampensis).

In addition to natural cattail marshes, narrow linear freshwater wetlands dominated by Cattail (Typha sp.) occur along mosquito ditches throughout the Keys. These ditches are flooded by freshwater during the wet season and, due to the high water-holding capacity of the deep organic layer, contain wet to moist soils throughout the year.

B. Existing Commercial, Recreational, or Conservation Uses of Freshwater Wetlands

Uses in Freshwater Wetlands on Private Lands
Uses in freshwater wetlands are restricted to utility pilings and elevated walkways. Sections 9.5-262 and 9.5-343 of the Monroe County Land Development Regulations (LDR's) (Monroe County BOCC, 1990) establish a 100 percent open space requirement for all land use districts vegetated with freshwater wetlands, with an allocated density (du's/ acre) and maximum net density (du's/buildable acre) of 0.2 and 0.0 respectively.

Section 9.5-345 of the LDR's (Monroe County BOCC, 1990) lists specific restrictions in freshwater wetlands as follows:

(a) "only utility pilings and elevated walkways shall be permitted in freshwater wetlands;

(b) all structures in freshwater wetlands shall be constructed on pilings or other supports; and

(c) no fill shall be permitted in any freshwater wetlands.

Conservation Lands Encompassing Large Tracts of Freshwater Wetlands
Freshwater wetlands located north of Watson Boulevard on Big Pine Key are largely owned by the FWS and are included in the National Key Deer Refuge. Several freshwater wetlands located south of Watson Boulevard are now scheduled for acquisition by FWS through its program for purchasing Key deer movement corridors (U.S.FWS, 1991a) or by the SFWMD through the Big Pine Key Save Our Rivers Project. Wetlands acquired by SFWMD will be conveyed to FWS as additions to the National Key Deer Refuge.

Outside of Big Pine Key freshwater wetlands, found on Cudjoe Key, No Name Key, Ramrod Key and Sugarloaf Key, remain in private ownership.

C. Known Pollution Problems and/or Issues Related to Freshwater Wetlands

Until 1986, freshwater wetlands in the Florida Keys were filled routinely for purposes of providing dry land for development. Some were used as borrow pits or for limestone mining. In 1986 Monroe County adopted its current Land Development Regulations (see above) which effectively stopped such activities in the Keys.

Pollution problems and other concerns related to freshwater wetlands which remain today include:

(a) illegal dumping;

(b) damage from off-road vehicles;

(c) disruptive activities at the fringe of freshwater wetlands caused by the proximity to developed land uses;

(d) problems related to groundwater quality deterioration as a result of existing population levels and wastewater disposal practices; and

(e) groundwater withdrawals from irrigation wells.

Illegal dumping is a problem along the perimeter of freshwater wetlands, particularly where there is vehicular access. This is of special concern due to the potential dumping of uncontained hazardous wastes which can leach into the soil and enter groundwater.

Due to ease of access many freshwater wetlands suffer disturbances from off-road vehicles and heavy equipment. Wetland plants are very susceptible to compaction. Where they are killed by repeated vehicular use, soil conditions are usually unfavorable for their recolonization. Track once formed usually remain bare or are revegetated by invasive plant species.

Close proximity of developed land uses to freshwater wetlands tends to adversely affect perimeter areas of the wetland. These impacts are typically direct physical effects caused by landowner dumping of yard debris at the perimeter of residential lots and the cumulative impacts of homeowners through the years caused by yard improvements, such as perimeter clearing, minor spot filling, and planting of non-native plant materials.

Horizontal flow of groundwater contaminated with nutrients is the major source of nonpoint source nutrient transport to surface freshwater resources. On Big Pine Key, nutrient pollution of groundwater results primarily from inadequate treatment of wastewater by on-site sewage disposal systems (OSDS), with secondary contamination from discharges from 49 aerobic treatment units used in conjunction with either an injection well (depths of the boreholes vary between 36' and 135') or drainfields (Lapointe, 1989b). Other less significant contaminant sources include cesspits and fertilizers.

Nutrient polluted groundwater in the freshwater lenses flows down-gradient into contiguous surface waters as a function of "wet-dry" seasonality (Lapointe, 1989b). Nutrient concentrations of surface waters are highest in the spring-summer-fall wet season when there is greater release of contaminated water from the subsurface freshwater lenses. During this period there are greater anthropogenic loading rates to groundwater (due to increased transient residential populations) and greater hydraulic head due to increased rainfall (recharge). Further, seasonally-maximum tides and water table heights during spring-summer-fall reduce the septic tank vadose zone, thus exacerbating direct flow of OSDS nutrients (Lapointe et al., 1990b).

Cumulative nutrient pollution of groundwater and contiguous freshwater resources on Big Pine Key is evidenced in the obvious "greening" and eutrophication of the Blue Hole which has occurred annually since the late 1980's. Nutrient loading to the Blue Hole aquatic ecosystem has increased as a result of recent residential development in the southwest watershed, where single family residences with OSDS's are a short distance up-gradient in the localized Blue Hole watershed (Lapointe, 1989b).

Water is withdrawn from freshwater lenses on Big Pine Key from numerous private and commercial wells for irrigation of lawns and plant nurseries. Recent investigations show that the effects of increased withdrawals to service new development and dredging have resulted in a decrease in

lateral extent and maximum depth of the southeast lens on Big Pine Key (Stewart et al, 1989). Shrinkage of the lens may over the long-term decrease groundwater flows to freshwater wetlands.

D. Potential for Conservation, Use or Protection of Freshwater Wetlands

Continued government acquisition of freshwater wetlands in the Lower Keys offers the greatest opportunity for conservation of these critical resource areas. Acquisition efforts should continue to focus on freshwater wetlands, freshwater ponds, buffer areas, and the critical recharge areas of the groundwater lenses which sustain freshwater flows into the wetland habitat areas.

In order to address impacts on freshwater wetlands related to groundwater contamination and groundwater quantity, studies are needed to map and evaluate the freshwater lens systems, including their recharge areas, throughout the Lower Keys. Particular attention should be given to Big Pine Key where the largest freshwater wetlands occur and where federally-designated species are reliant upon the continued source of freshwater in these areas. Upon completion of these studies regulations should be considered for adoption, as appropriate, to limit future groundwater withdrawals, to further limit impervious surfaces in critical recharge areas, to restrict non-point sources of water pollution in critical recharge areas (such as storage tanks and hazardous waste handling facilities), and to require alternative technologies for on-site wastewater disposal as may be found suitable for use in the Keys through the Sanitary Wastewater Master Plan (see Sanitary Sewer Chapter).

Off-road vehicle trespassing onto freshwater wetlands could be reduced through improved posting of private lands and by stepped-up enforcement of trespass laws and illegal use of public lands by the Environmental Crimes Task Force.

Illegal dumping in Monroe County, including dumping in freshwater wetlands, could be reduced through "neighborhood pick-up days" during which the County removes clean residential solid waste free-of-charge. Stepped-up enforcement of existing dumping regulations by the Environmental Crimes Task Force could also reduce illegal dumping.

In order to better protect freshwater wetlands from the impacts of man's activities on adjacent lands, the Land Development Regulations should be revised to require minimum vegetated setbacks from wetlands for adjacent upland development.

3.9.8 Disturbed Wetlands

A. General Characteristics of Disturbed Wetlands

Disturbed land is defined as follows in the Monroe County Land Development Regulations (Monroe County BOCC, 1990):

> "Disturbed land means land that manifests signs of environmental disturbance which has had an observable effect on the structure and function of the natural community which existed on the site prior to the disturbance."

Consistent with this definition, disturbed wetland communities show obvious signs of environmental disturbance which has had an observable effect on the original wetland community.

In the Keys a number of human activities have created disturbed wetlands, including:

placement of fill or dredge spoils on wetlands;
clearing of vegetation;
removal of topsoil;
impoundment of wetlands;
drainage of surface waters;
blockage of surface drainage;
restriction of tidal circulation;
introduction of exotic vegetation; and
excavation or dredging of uplands or wetlands.

These activities have re-directed or delayed primary succession and have caused "secondary succession" to take place. Secondary succession occurs on sites where the natural community has been obliterated, i.e. a bare area open to invasion by colonizing plants and animals. The degree to which wetlands have been altered will have an effect on the functional value of the wetland.

Disturbed wetlands are being mapped and evaluated as part of the ADID Program (see Section 3.9.2 above). Preliminary indications from this program suggest that disturbed wetland delineations will primarily encompass disturbed salt marsh and buttonwood wetlands having low functional value. Vegetation typical of disturbed salt marsh and buttonwood wetlands is described in Section 3.9.4.A. above.

B. Existing Commercial, Recreational or Conservation Uses of Disturbed Wetlands

Disturbed salt marsh and buttonwood wetlands in Monroe County generally occur on disturbed residential lots in Improved Subdivision (IS), Commercial Fishing Village (CFV), and Urban Residential Mobile Home (URM) zoning districts. (See Section 3.9.4.B above for further discussion of existing uses and regulatory procedures applicable to disturbed salt marsh and buttonwood wetlands.)

Disturbed wetlands in public ownership on conservation lands (see Section 3.18) are few and widely scattered.

C. Known Pollution Problems and/or Issues Related to Disturbed Wetlands

Applications for residential structures, particularly in improved subdivisions (IS lots) constitute the largest day-to-day permit load for Monroe County. Most of these applications are for filling in disturbed salt marsh and buttonwood wetlands. (The Land Development Regulations (Monroe County BOCC, 1990) require 100 percent open space in mangroves, salt ponds, and freshwater wetlands. This effectively eliminates permit applications for filling in these wetlands.)

Ultimately, owners of lots characterized by disturbed salt marsh and buttonwood wetlands (see above) can be expected to request permits from DER, COE and Monroe County to fill a portion of

the remaining wetlands on their lots. On most, this will likely be necessary in order to accommodate a house and accessory structures.

Based upon present county, state and federal policies and regulations (see Section 3.9.4.B above), permits would generally be issued for these lots, subject to mitigation requirements. As noted in Section 3.9.1 above, mitigation usually takes the form of compensation and/or compliance with environmental design criteria as outlined in the Land Development Regulations (Monroe County BOCC, 1990). Given current county wetlands planning procedures, issuance of filling in disturbed wetlands in Monroe County subject to these requirements does not require "no net loss" of wetlands functional value.

D. Potential for Conservation, Use or Protection of Disturbed Wetlands

In general, future development in the County should be directed to the maximum extent possible away from disturbed wetlands. This should be accomplished through land use policies of the Comprehensive Plan and its implementing land development regulations. In developing the Permit Allocation System for implementation of the Plan, consideration should be given to assigning a negative point to developments proposed in disturbed wetlands (see Future Land Use Element Section 2.4.1.B).

The ADID Program (see Section 3.9.2 above) will map wetlands throughout the Keys and establish the functional value of disturbed wetlands. Based upon this information, Monroe County should review and revise as appropriate the open space requirements and environmental design criteria for disturbed wetlands, with particular attention given to saltmarsh and buttonwood wetlands. These revisions should be designed to eliminate the net loss of disturbed wetlands. Particular attention should be directed to establishing appropriate design criteria for all types of structures, accessways, and on-site disposal systems which serve projects requiring filling in disturbed wetlands.

Restoration of disturbed marine and freshwater wetlands in the Keys should be undertaken to restore biological functions. The Monroe County Biologist in consultation with the EPA, COE, SFWMD, FGFWFC and FWS should identify priority sites for wetlands restoration in the County. In the future, any monies collected as impact mitigation fees from parties permitted to fill in disturbed wetlands should be paid into a wetlands restoration fund to be used by the County for restoration of publicly-owned wetlands. Fines collected for wetlands violations by the Environmental Crimes Task Force should also be deposited in the County Restoration Fund. Restoration on private lands should be encouraged through landowner education and required as a condition of land development orders.

3.10 Beach/Berm Communities

3.10.1 Beach/Berm Communities of the Florida Keys

Beach/berm formation in the Florida Keys is relatively infrequent and is not directly comparable to the broad coastal strand communities in other areas of the state (Florida DNR, 1989b). Extensive beach development in many areas is precluded due to the offshore coral reefs and gently sloping bottom of Hawk Channel which dispense oceanic wave energy. Where beaches and wetlands are not present, the shoreline is characterized by exposed, pitted and pinnacled limestone.

The typical beach system in the Keys is comprised of a beach and associated berm. The most seaward component is the "beach" which is material, usually sand, that extends from the upper berm to the low water mark (Clark, 1977). In the Keys beaches are typically 15 to 25 feet in width, reaching a maximum width of 60 feet in a few areas, such as on Bahia Honda Key.

The berm is a mound or ridge of unconsolidated sand that is immediately landward of, and usually parallel to, the shoreline and beach. The berm is higher in elevation than both the beach and the area landward of the berm, ranging from slightly above mean high water to more than 7 feet above mean sea level. Berms in the Keys vary in width from 20 to 200 feet. In some locations berms occur without a beach along the shoreline. Instead, there is a narrow band of fringing mangroves along the waterward edge of the berm.

A. DNR Beach/Berm Inventory

DNR has recently completed an inventory of the beaches of the Florida Keys. Findings of this inventory indicate that beaches are not common in the Keys (see Table 3.9). In general, beach frequency increases to the southwest, with the largest percentage of land mass composed of beach found on Bahia Honda Key, the outer islands west of Key West (Sand Keys), the Marquesas Keys, and the Dry Tortugas (Florida DNR, 1990b).

There are approximately 25.6 miles of beach in the Middle and Lower Keys, exclusive of Key West and Key Colony Beach (see Table 3.9). Numerous other natural beaches occur on the Mainland and on the islands west of Key West (Sand Keys, Marquesas Keys and Dry Tortugas). There are no natural beaches in the Upper Keys, north of Upper Matecumbe Key.

The Comprehensive Plan Map Atlas includes maps showing the beach/berm areas of the Upper, Middle and Lower Keys and selected offshore islands. These maps are available at a scale of 1"=2,000' and can be reviewed at the Monroe County Department of Planning.

B. FNAI Inventory of Significant Undisturbed Beach/Berm Communities

The Florida Natural Areas Inventory (FNAI) has identified 12 coastal berms, 5 beach dunes, and 4 coastal rock barrens in the Florida Keys (excluding Dade County and Key West) which are characterized by relatively undisturbed upland vegetation (see Table 3.10)(Kruer, 1991). These parcels range in size from one to 85 acres.

FNAI has identified these communities as the significant undisturbed coastal berms, beach dunes, and coastal rock barrens in the Keys. Because of their extremely limited distribution, these biological communities are considered by FNAI to be of state and national importance.

3.10.2 Flora of Beach/Berm Communities

Four distinct beach zones are generally recognized in the Florida Keys. Moving landward from the shoreline, these include:

(a) beach dune comprised of:

i. a strand-beach association of pioneer halophytic species; and
ii. an essentially herbaceous strand-dune association, on the fore part of the low dunes;

(b) a strand-scrub association;

(c) a strand-hammock association (or coastal berm); and

(d) coastal rock barren.

This generalized zonation scheme (exclusive of the coastal rock barren) is typically found only on the most highly developed beach systems, such as on the keys between Key West and the Dry Tortugas. On the remaining keys, this distinct zonation with some variation, occurs on Bahia Honda, Lower Sugarloaf, Big Pine, Newfound Harbor Keys and Content Keys. On other keys, this zonation complex is not as well developed.

The strand-beach association is dominated by plants that are salt tolerant, root quickly, germinate from seed rapidly, and can withstand wave wash and shifting sand. Commonly found species include the Sea Purslane (Sesuvium potulacastrum), Railroad Vine (Ipomoea pes-caprae), Beach Grass (Panicum amarulum), Sea Oats (Uniola paniculata), Sea Lavender (Tournefortia gnapholodes), Coastal Ragweed (Ambrosia hispida), Bay Cedar (Suriana maritima), Cenchrus and Chamaesyce. On most keys beaches this association occurs only at the base of the berm since the beach is very narrow.

The strand-dune association begins with a steep and distinct increase in slope upward from the beach. The foreslope of the berm, or beach ridge, is vegetated primarily by species found in the strand-beach association. Proceeding landward, these pioneer species are joined by others, such as Chaff Flower (Alternanthera maritima), Sea Daisy (Borrichia frutescens), Cordgrass (Spartina patens), Beach Orach (Atriplex arenaris), Spider Lily (Hymenocallis latifolia), and Sea Rocket (Cakile lanceolata). On a number of beaches, Australian Pines (Casuarina equisetifolia) have become established in this zone. Another exotic, (Colubrina asiatica), has also become established, forming dense thickets in the seaward portion of the berm.

The strand-scrub association is generally considered a transition zone between strand-dune and hammock forest. Shrubs and occasional trees occur more frequently and become more abundant moving landward. Species often found include Seagrape (Coccoloba uvifera), Wild Sage (Lantana involucrata), Seven-year Apple (Casasia clusiifolia), Blolly (Guapira discolor) Gray Nicker (Caesalpina crista), Blackbead (Pithecellobium guadalupense), Nightshade (Solanum bahamense), and the Prickly Pear Cactus (Opuntia sticta). Occasional larger trees include Buttonwood, Large Seagrape, Blolly, Gumbo Limbo (Bursera simaruba), and Jamaica Dogwood (Piscidia piscipula). Vegetation occurring as an understory or in open areas includes many of the above mentioned graminoids and herbs, as well as Natal Grass (Rhynchelytrum repens), Spanish Needles (Bidens alba) and Yellowtop (Flaveria linearis).

Coastal rock barren is a very rare ecotonal community occurring as tiny patches along rocky shorelines in the Keys (Kruer, 1991). It is an upland community influenced by storm tides but

Table 3.9

Monroe County Natural Beach Inventory (1)

Map Unit	Beach Location		Total Length (ft.)	Average Width (ft.)	Net Sediment Transport Direction	Ownership
710A	Upper Matecumbe Key	Shoreline fronting Florida Straits	9,800	15	southwest	Private
710B	Lower Matecumbe Key	Shoreline fronting Florida Straits	14,900	15	southwest	Private
710C	Lower Matecumbe key	Calusa Cove	2,200	25	southwest	Private
710D	Long Key	Shoreline fronting Florida Straits State Recreation Area)	15,800	25	west	State
710E	Long Key	West end of shoreline fronting Florida Straits	2,700	25	west	Private
710F	Toms Harbor Key	Shoreline fronting Florida Straits	2,400	15	northeast/southwest	Private
710G	Grassy Key	Shoreline fronting Florida Straits	6,800	15	southwest	Private
710H	Crawl Key	Peninsula known as Valhalla	600	15	northeast	Private
710I	Little Crawl Key	Eastern half	1,200	15	west	Private
710J	Fat Deer Key	Coco Plum Beach	7,500	25	southwest	Private
710K	Boot Key	Sunrise Isle Beach	2,000	15	north	Private
710L	Boot Key	Sombrero Beach	1,600	25	east	Monroe Co.
710M	Vaca Key	East shore Vaca Key (adjacent to Sister Creek)	800	15	north	Private
710N	Boot Key	Shoreline fronting Florida Straits	7,000	25	indeterminant	Private
710O	Little Duck Key	Shoreline fronting Florida Straits	825	25	southwest	Monroe Co.
710P	Missouri Key	Shoreline fronting Florida Straits	500	15	indeterminant	Monroe Co.
710Q	Ohio Key	Shoreline fronting Florida Straits	1,600	15	southwest	Private
710R	Bahia Honda Key	Shoreline fronting Florida Straits; Gulf of Mexico shoreline (Bahia Honda State Recreation Area)	11,900	50	southwest	State
710S	Bahia Honda Key	Gulf of Mexico shoreline (Bahia State Recreation Area)	800	- (2)	indeterminant	State
710T	Spanish Harbor Key	Shoreline fronting Florida Straits	1,000	15	southwest?	Monroe Co.
710U	Big Pine Key	Eastern shore of Southeast Point	4,000 (4)	15	southwest?	U.S. FWS
710V	Big Pine Key	Long Beach	8,000	15	southwest?	
710W	Cooks Island	Shoreline fronting Florida Straits	2,400	15	southwest?	
710X	Big Munson Island	Shoreline fronting Florida Straits	6,000 (4)	15	southwest?	
710Y	Munson Island	Shoreline fronting Florida Straits	600	15	southwest?	
710Z	Ramrod Key	Southwest Point	7,000	15	indeterminant	Private
710AA	Sugarloaf Key	Sugarloaf Beach	8,000 (4)	15	southwest	Private
710BB	Boca Chica Key	Shoreline fronting Florida Straits	7,300	15	southwest?	Federal
-	"Back Country Islands" (3)	Gulf of Mexico shoreline	6,100	25	predominantly southwest?	
-	Outer Islands Near Key West		2.6 miles	-	-	
-	Marquesse Keys		4.5 miles	-	-	
-	Dry Tortugas		4.5 miles	-	-	

(1) Excluding beaches of the Mainland Monroe County, Key Colony Beach, and Key West.
(2) Indicates data not available from source material.
(3) Including Mud Key, Snipe Keys, Marvin Key, Sawyer Key and Content Keys.
(4) Not included in Florida DNR, 1989b.

Source: Florida DNR, 1990b.

Table 3.10

Inventory of Significant Undisturbed Coastal Berms, Beach Dunes and Coastal Rock Barrens

Site #	Site Name	Ranking	Size (acres)	Ownership			Public / Non-Profit Landowner
				Public	Private	Non-Profit	
Coastal Berms							
MONR-35	Big Munson	A	14	0	0	14	Boy Scouts of America (not protected)
MONR-57	Marquesas Long Beach	A	85	85	0	0	Key West National Wildlife Refuge
MONR-2	North Key Largo Hammocks	B	3	3	0	0	Key Largo Hammocks State Botanical Site
MONR-17	Long Key Berms and Hammocks	B	36	36	0	0	Long Key State Recreation Area
MONR-23	Bahia Honda	B	36	36	0	0	Bahia Honda State Recreation Area
MONR-33	Long Beach	B	23	8	15	0	Key Deer National Wildlife Refuge; private lands are within Coupon Bight CARL Project
MONR-41	Ramrod Berms and Hammocks	B	9	0	9	0	-
MONR-53	Sawyer Key Berms	B	4	1	3	0	Great White Heron National Wildlife Refuge
MONR-56	Boca Grande Dunes and Hammock	B	2	2	0	0	Key West National Wildlife Refuge
MONR-58	Marquessa Southwest	B	51	51	0	0	Key West National Wildlife Refuge
MONR-52	Sugarloaf Beach	C	7	0	7	0	-
MONR-11	Plantation Key	D	3	0	3	0	-
	Total Coastal Berms		**273**	**222 (82%)**	**37 (14%)**	**14 (5%)**	
Beach Dunes							
MONR-56	Boca Grande Dunes and Hammock	A	16	16	0	0	Key West National Wildlife Refuge
MONR-55	Woman Key	B	11	11	0	0	Key West National Wildlife Refuge
MONR-57	Marquessas Long Beach	B	5	5	0	0	Key West National Wildlife Refuge
MONR-58	Marquesas Southwest	B	10	10	0	0	Key West National Wildlife Refuge
MONR-23	Bahia Honda	C	4	4	0	0	Bahia Honda State Recreation Area
	Total Beach Berms		**46**	**46 (100%)**	**0**	**0**	
Coastal Rock Barrens							
MONR-17	Long Key Berms and Hammock	B	2	2	0	0	Long Key State Recreation Area
MONR-18	Vathalla	B	7	0	7	0	-
MONR-35	Big Munson	B	1	0	0	1	Boy Scouts of America (not protected)
MONR-12	Windley Key Quarry	C	1	1	0	0	Windley Key State Geological Site
	Total Rock Barrens		**11**	**3 (27%)**	**7 (64%)**	**1 (9%)**	

Coastal berms, beach dunes and coastal rock barrens which are owned and protected for conservation purposes.

Rankings

A - Excellent
B - Good
C - Fair
D - Poor

Rankings are based on degree of disturbance, degree of exotic plant invasion, species diversity, structural diversity, relative size, and the extent edges are intact. Entire sites are given the same rank even though quality may not always be consistent throughout a site. Protection of the high quality portion of a site is dependent on protection of the perimeter or buffer.

Source: Derived from Kruer, 1991 (prepared for the Florida Natural Areas Inventory).

above the predictable spring high tide line (Kruer, 1991). It is generally characterized as having sparse, low vegetated, flat rocklands, with xeric and halophytic plants and cacti, and considerable exposed and eroded limestone (Kruer, 1991).

The most landward zone on the berm is occupied by tropical hardwood hammocks (see Tropical Hardwood Hammocks Section 3.11.1 below).

3.10.3 Existing Commercial, Recreational or Conservation Uses of Beach/Berm Communities

Developed uses on natural beaches in the Keys are generally limited to single family homes and condominiums. In some locations, most notably at Holiday Isle and Islamorada, hotel owners have built beaches which are used for or in support of tourist commercial uses.

Several beaches inventoried by DNR (Florida DNR, 1989b) are protected through public ownership and are available for public recreation purposes (see Table 3.9). These include:

Beach	Ownership
Long Key State Recreation Area (beach fronting Florida Straits)	DNR
Bahia Honda State Recreation Area	DNR
Sombrero Beach	Monroe County
Little Duck Key Beach	Monroe County
Missouri Key Beach	Monroe County
Spanish Harbor Key Beach	Monroe County
Big Pine Key Beach (eastern shore of southeast point)	U.S.FWS
Boca Chica Key Beach	U.S.Navy.

As indicated in Section 3.10.1.B above, FNAI has identified approximately 503 acres of significant undisturbed tracts of coastal berm, beach dune and coastal rock barren communities in unincorporated Monroe County. Of these, approximately 433 acres (86 percent) are protected through public ownership for conservation purposes (derived from Kruer, 1991). All of the identified excellent quality beach dune communities are protected.

Conservation lands in the Keys which include significant undisturbed beach/berm communities are summarized as follows (derived from Kruer, 1991):

Conservation Land	Acres of Significant Beach/Berm Habitat
Key West National Wildlife Refuge	180 ac.
National Key Deer Refuge	8 ac.
Great White Heron National Wildlife Refuge	1 ac.
Long Key State Recreation Area	38 ac.
Bahia Honda State Recreation Area	40 ac.
Key Largo Hammock State Botanical Site	3 ac.
Windley Key State Geological Site	1 ac.

A total of 44 acres of significant beach/berm habitat remains in private ownership, and an additional 15 acres, owned by the Boy Scouts of America, are considered unprotected. None of these lands are within CARL Project areas.

3.10.4 Known Pollution Problems and/or Issues Related to Beach/Berm Communities

Pollution problems and disturbances related to beach/berm communities in the Keys include the following:

(a) general loss of beach/berm habitat to developed land uses;

(b) clearing of berm vegetation for land development;

(c) establishment of exotic vegetation;

(d) beach erosion due to human use and off-road vehicles; and

(e) natural beach erosion.

Monroe County permits a variety of uses as-of-right, and as minor and major conditional uses in beach/berm areas. Section 9-5.343 of the Land Development Regulations (LDR's)(Monroe County BOCC, 1990) establishes open space requirements of 90 percent and 20 percent for undisturbed beach/berm and disturbed beach/berm, respectively. In addition the LDR's protect beaches through a shoreline setback requirement, as follows:

(a) fifty (50) feet from natural water bodies with unaltered shorelines or unlawfully altered shorelines, measured from the landward limit of mangroves, if any, and where mangroves do not exist, from the mean high tide line; and

(b) fifty (50) feet from any shoreline area which is known to serve as an active nesting or resting area for marine turtles, terns, gulls and other birds.

Because most beaches in the Keys are narrow, the shoreline setback effectively restricts development activities on beaches. However, development is permitted on berms, subject to environmental design criteria which limit clearing, impervious surfaces, lighting, excavations, fill and landscaping.

Since adoption of the LDR's in 1986, these regulations have reduced the amount of habitat loss which would have otherwise occurred. Development, however, has continued to take place on undisturbed beach/berms throughout the Keys. With this development there has been not only direct habitat loss, but introduction of increased human activity. This places further stresses upon the remaining undisturbed beach/berm habitat retained as open space in development projects as well as adjacent undeveloped areas.

As a condition of Development Orders for projects in beach/berm areas the County requires that measures be taken to prevent disturbance to areas to be retained as open space. Despite this, it is not uncommon for site disturbances to occur outside the approved construction area. The result is

typically loss of native beach/berm vegetation, with replacement by non-native landscaping materials or, where disturbed areas are left bare, invasion by exotic plants. This loss of native beach/berm material directly threatens the immediate area by destabilizing the loose sand substrate, which then is subject to rapid erosional loss, especially under storm conditions and colonization by invasive plants.

In general, widespread establishment of exotic vegetation has placed Keys beach communities under stress. The most invasive species are Australian pine (Casuarina equisetifolia) and leatherleaf (Colubrina asiatica), both of which are very competitive with native plants. Brazilian pepper (Schinus terebinthefolius) may also be a problem in some areas, but is not nearly as widespread on beaches in the Keys.

Beach erosion is typically due to natural causes, exacerbated by human activities (walking, off-road vehicles, and disturbances associated with adjacent development) which have disturbed natural beach vegetation, facilitated colonization by invasive plants, and weakened the sandy beach substrate. DNR has identified seven beaches in the Keys which are experiencing natural beach erosion (Florida DNR, 1989b) (see Section 3.10.5 below). Beach erosion due to human activities has been greatest, although not a significant problem, on Coco Plum Beach and Grassy Key Beach.

Generally there is not a serious problem with use of off-road vehicles (ORV's) and all-terrain vehicles (ATV's) on beaches in the Keys due to their limited size and extent, difficulty of access, and unstable substrate. ORV and ATV use and associated damage on natural beaches is most evident on Coco Plum Beach and Grassy Key Beach.

3.10.5 Past Trends in Beach Erosion and Accretion

Past trends in beach erosion and accretion in the Florida Keys have not been well researched. Historical studies of beach erosion exist only for the south shores of Key West and Bahia Honda Key. Documentation of erosion control efforts is also unavailable.

A. General Beach Accretion Trends

In general, beach formation in the Keys is limited by reduced wave action in the Straits of Florida coupled with a lack of sand available for transport. The southward net transport of sand along the Atlantic barrier beaches of Florida, which builds and renourishes the beaches of South Florida north of the Keys, diminishes substantially at the southern end of Dade County. While quartz sand deposits do exist in shoals south of Key Biscayne, there is little southward sand transport from there to Soldier Key. There are a number of physical reasons for the lack of sand transport between the barrier islands and the Florida Keys. Little Bahama Back and Great Bahama Bank provide substantial protection to the shoreline from Atlantic Ocean swell. As a result, wave action needed to transport sand to the shore is greatly diminished in the Straits of Florida. Furthermore, in offshore areas any sand which may exist is influenced by the strong northward current of the Gulf Stream which blocks any southward sediment transport (Florida DNR, 1989b).

As a result of these conditions, the narrow beaches characteristic of the Keys are created by an interaction of low wave energy and coarse sand. The berms or sand ridges result from storm waves which transport sand from the shallow submerged bottoms and beach zones landward. The sands

that form the beaches and berms of the Keys are of carbonate origin derived from the erosion of limestone, from aragonite particles precipitated from seawater, and from the fragmented remains of corals, cast-off shells, and calcareous algae. These fragmentary particles are generally coarse and angular, in contrast to the fine particles of silica that form the sands of most northern beaches. This coarse fraction of sediments is sorted from the fine by the action of waves and currents. Coarse material is deposited in the higher energy areas such as beaches and slope tops of channels, whereas the fine muds end up in quiescent areas such as mud banks, shallow embayments, and mangrove fringes.

Subsequent to deposition of this material on the beach, it is either carried upward to the berm by storm waves or transported offshore by nearshore currents. Because of its relatively large size and angularity, this sand is not readily transported by the wind as are the siliceous sands of mainland beaches. This explains the absence in the Keys of the shifting or high dunes characteristic of beaches on the middle Atlantic shore.

B. Beach Erosion Trends

The primary causes of beach erosion in the Keys are major storm events, onshore and alongshore sediment budget deficits, historical development trends, and long-term sea level rise. Several beach areas in the Middle and Lower Keys have experienced or are currently experiencing severe erosion. Approximately 23,100 linear feet of the beaches (22 percent) are described by DNR as having erosion problems (see Table 3.11). Of these, 8,990 linear feet are classified as critical and 14,090 linear feet are classified as noncritical. The following is a general description of the beach erosion problems documented on seven beaches of the Middle and Lower Keys (Florida DNR, 1989b):

Long Key State Recreation Area Beach (Long Key)(Florida DNR, 1989b, p.19)

Critical erosion of 2,950 feet of shoreline exists along the camping and swimming areas within the Long Key State Recreation Area. Division of Recreation and Parks officials have estimated the shoreline recession to be as much as three feet per year since the park was opened in 1970. A 750-foot long limerock revetment was constructed in 1976 to protect the park road; however, erosion end effects are most apparent adjacent to the revetment. Park officials continually remove tall Australian pines which are undermined by the erosion processes.

Coco Plum Beach (Fat Deer Key)(Florida DNR, 1989b, p.20)

Approximately 3,170 feet of shoreline along Coco Plum Beach is experiencing noncritical erosion. A terminal rock groin has been constructed at the east end of the beach and two rock groins have been constructed at the west end. The net sediment transport direction is to the southwest, as seen by the severe erosion west of the eastern groin and by the accretion at the west groins.

Sombrero Beach (Vaca Key)(Florida DNR, 1989b, p.20)

The eastward transport of beach sediment off Sombrero Beach and into the adjoining canal to the east has resulted in critical erosion. At least one beach nourishment effort was

conducted in 1975 when about 60 to 70 cubic yards of sand were brought in by truck. The construction of a terminal groin is needed at the eastern end of the beach to prevent continued erosion losses and to stabilize beach nourishment.

Bahia Honda State Recreation Area Beach (710R)(Bahia Honda Key)(Florida DNR, 1989b)(pp.21 and 22)

Coastal Technology Corporation (1987) estimates a net longshore sediment transport direction to the north at a rate of 90 cubic yards per year along the 600-foot long public recreation beach between the Flagler Bridge and the U.S. Highway 1 Bridge. This beach and the western 3,500 feet of beach fronting directly on the Straits are experiencing critical erosion. Based on a comparison of 1971 and 1986 aerial photography, Coastal Technology Corporation estimated a maximum erosion rate of -5 feet per year on the west beach.

Early efforts to mitigate erosion conditions on Bahia Honda Key include placement of 24-inch by 36-inch concrete bridge piles near the west end of the island. In the early 1970's, riprap was placed along 400 to 500 feet of the erosion threatened roadway adjacent to the western beach. Between 1981 and 1986, the park staff planted sea oats to mitigate continued erosion in the area. The area was subsequently armored by a 1,200-foot long limerock revetment, constructed between October, 1988 and January, 1989 to protect the park road. At the north end of the 600-foot inner beach, a 100-foot terminal groin was constructed in October, 1989. Beach sediment losses occurred when sand was transported into the adjacent marine entrance channel. In April, 1989, 300 cubic yards of sand was excavated from the channel and placed on the beach above mean high water; an additional 240 cubic yards of sand screened from limerock aggregate at Rockland Key was placed on the beach. Currently, however, additional nourishment is critically needed. The eastern 7,400 feet of beach of Bahia Honda is known as Sand Spur Beach which, with prominent vegetated barrier dunes and a beach averaging 60 feet in width, appears stable for most of its length. Only along a 650-foot eastern segment is noncritical erosion occurring. the park staff has planted sea oats and constructed beach access structures on Sand Spur Beach.

Long Beach (Big Pine Key)(Florida DNR, 1989b, p.23)

Much of the Straits shoreline of Big Pine Key is a coarse-grained sandy, perched beach. Although mollusks and coral fragments provide an available source for natural renourishment and a prominent barrier dune backs much of the shoreline (providing a feeder source of sediment), erosion has substantially reduced the width and quality of the beach...Continued development pressures along the privately owned beaches of Big Pine Key can be expected to substantially impact the barrier dune. No erosion control structures exist in the area.

Sugarloaf Beach (Sugarloaf Beach)(Florida DNR, 1989b, p.23)

Like Long Beach of Big Pine Key, Sugarloaf Beach is a narrow, severely eroded, perched beach fronting a prominent barrier dune. There are a couple of bulkheads and one shore-normal breakwater along this shoreline which has an estimated direction of net annual longshore sediment transport to the southwest.

Boca Chica Beach (Boca Chica Key)(Florida DNR, 1989b, p.24)

Half of Boca Chica Key's shoreline is a natural mangrove shoreline and half is a narrow severely eroded coarse-grained sandy shoreline...According to local residents the 7,300 feet of sandy beach was wide prior to the 1944 and 1948 hurricanes which inflicted severe erosion throughout the area.

3.10.6 Effects of Coastal or Shore Protection Structures on Beach/Berm Communities

Coastal protection structures have been used throughout the Keys for purposes of reducing shoreline erosion, including erosion on beaches. Groins have been successfully used at Bahia Honda State Recreation Area Beach and Coco Plum Beach to slow erosion processes (Florida DNR, 1989b). The DNR has not specifically identified any instances of adverse impacts on beaches associated with shoreline protection structures, such as groins, breakwaters, riprap and bulkheads (Florida DNR, 1989b).

3.10.7 Existing and Potential Beach Renourishment Areas

The DNR has identified two beaches in the Lower and Middle Keys (excluding Key West) where beach renourishment has occurred (Florida DNR, 1989b):

Sombrero Beach (Vaca Key)(Florida DNR, 1989b, p.20)

In 1975, approximately 60 to 70 cubic yards of sand were brought in by truck to renourish Sombrero Beach on Vaca Key.

Bahia Honda State Recreation Area Beach (Bahia Honda Key)(Florida DNR, 1989b, p.22)

In April 1989, 300 cubic yards of sand were excavated from the channel off Bahia Honda and placed on the beach above mean high water; an additional 240 cubic yards of sand screened from limerock aggregate at Rockland Key was placed on the beach. Currently additional nourishment is critically needed.

There are no ongoing beach renourishment projects in the Keys.

Recommendations for identified beach erosion areas in the Middle and Lower Keys, included in "Florida's Beach Restoration Management Plan" (Florida DNR, 1989b), call for development and implementation of beach restoration plans for Long Key State Recreation Area Beach, Sombrero Beach and Bahia Honda State Recreation Area Beach. Beach renourishment, although not specifically recommended, would be considered as a restoration option for all three beaches.

Table 3.11

Monroe County Beach Erosion Problem Areas

Map Unit	Beach Location	Total Length (ft.)	Critical Length (ft.)	Non-Critical Length (ft.)	Recommendations for Beach Restoration
710D	Long Key (Long Key State Recreation Area)	3,170	3,170	0	1. Complete environmental study. 2. Complete sand source study. 3. Remove Austrailian Pines and replant with native species. 4. Develop and implement restoration plan, as appropriate (pending findings of studies).
710J	Fat Deer Key (Coco Plum Beach)	3,170	0	3,170	1. Acquisition of 3,300 feet of beach by Monroe County. 2. Develop and implement beach management plan.
710L	Vaca Key (Sombrero Beach)	1,600	1,600	0	1. Complete marine habitat study. 2. Complete sand source study. 3. Develop and implement restoration plan, as appropriate (pending findings of studies), probably including construction of a terminal groin.
710R	Bahia Honda Key (Bahia Honda State Recreation Area)	5,280	4,220	1,060	1. Complete marine habitat study. 2. Complete sand source study. 3. Complete wave refraction study. 4. Establish monument baseline. 5. Implement shoreline erosion monitoring programs. 6. Develop and implement restoration plan, as appropriate (pending findings of studies.
710V	Big Pine Key (Long Beach)	5,280	0	5,280	1. Enforce construction setback and dune preservation requirements. 2. Seek funding for public acquisition.
710AA	Sugarloaf Key (Sugarloaf Beach)	3,000	0	3,000	1. Enforce construction setback and dune preservation requirements. 2. Seek funding for public acquisition.
710BB	Boca Chica Key (Shoreline fronting Florida Straits)	1,580	0	1,580	No action needed while in federal ownership.
Total		**23,080**	**8,990**	**14,090**	

Source: Florida DNR, 1989b.

3.10.8 Potential for Conservation, Use or Protection of Beach/Berm Communities (including measures to protect or restore beach/berm communities)

A. Protection Measures Recommended by DNR

Measures to protect or restore the seven beaches experiencing erosion problems in the Middle and Lower Keys are recommended by the DNR in "Florida's Beach Restoration Management Plan" (Florida DNR, 1989b) (see Table 3.11). Measures generally include:

(a) possible beach restoration at Long Key State Recreation Area, Sombrero Beach and Bahia Honda State Recreation Area; and

(b) acquisition and improved beach management at Coco Plum Beach, Long Beach and Sugarloaf Beach.

No protection or restoration measures are recommended at the federally-owned beach on Boca Chica Key.

B. Protection Measures Identified by Monroe County

Acquisition is the most direct means of preserving remaining undisturbed beach/berm habitat areas in the Keys. This can be accomplished for some high priority beaches, particularly those which are suitable for recreation use, such as Coco Plum Beach. For many other beach/berm areas, acquisition is not a viable alternative due to lack of purchase funds.

Future development in the County should be directed to the maximum extent possible away from undisturbed beach/berms. This should be accomplished through land use policies of the Comprehensive Plan and its implementing land development regulations. In developing the Permit Allocation System for implementation of the Plan, consideration should be given to assigning a negative point to developments proposed in undisturbed beach/berms (see Future Land Use Element Section 2.4.1.B).

When development is permitted in undisturbed beach berm areas, there should be strict enforcement of the 90 percent open space requirements. The County should develop a set of construction standards for development in undisturbed and disturbed beach/berm areas which address clearing and actions to protett beach/berm vegetation outside of the construction site. These should be attached as conditions to Development Orders and should be strictly enforced by site inspections and fines levied for violations.

Restoration of beach/berm areas should be encouraged through both mandatory restoration as a condition of Development Orders, as well as through voluntary landowner action. A list of invasive exotic plants should be prepared by the County Biologist. All plants on this list should be removed from the development site (including sites on both undisturbed and disturbed beaches) as a condition for issuance of a Certificate of Occupancy. All areas disturbed during construction should be immediately restored to stable condition. Only native plants should be used for restoration and landscaping.

ORV and ATV impacts on beaches should be reduced through improved posting of regulations and by stepped-up enforcement of these regulations by the Environmental Crimes Task Force.

3.11 Upland Vegetation

There are two native upland biological communities in the Florida Keys. These are:

(a) tropical hardwood hammocks, the climax terrestrial community; and

(b) pinelands, a fire-climax system.

Many upland areas in the Keys have experienced disturbance of some kind which has interfered with natural succession in upland communities. These uplands comprise a third upland biological community in the Keys, referred to collectively as "disturbed lands".

The Comprehensive Plan Map Atlas includes maps showing areas within Upper, Middle and Lower Keys and selected offshore islands which are characterized by native upland vegetation and disturbed lands. These maps are available at a scale of 1"=2,000' and can be reviewed at the Monroe County Department of Planning.

Refined vegetation mapping is currently underway in Monroe County in coordination with the ADID Program (see Section 3.9 above). The work plan calls for:

(a) establishing a field method for mapping and preliminarily evaluating upland habitats;

(b) completing groundtruthing of upland habitats;

(c) entering groundtruthed data into the GIS; and

(d) plotting vegetation data at a scale of 1"=200'.

The project is scheduled for completion by September 30, 1993.

Information will be updated periodically utilizing information obtained from site specific habitat evaluation index reports.

3.11.1 Tropical Hardwood Hammocks

Tropical hardwood hammocks constitute the climax terrestrial community of South Florida and the Keys. This community is probably the richest in diversity, with approximately 100 species of wide tropical occurrence, present in the Keys and nowhere else in the continental United States.

The Comprehensive Plan Map Atlas includes maps showing the tropical hardwood hammocks of the Upper, Middle and Lower Keys. These maps are available at a scale of 1"=2,000' and can be reviewed at the Monroe County Department of Planning.

A. Flora of Tropical Hardwood Hammocks

Hammock communities occur as isolated stands of hardwoods or, "tree islands". These distinct tree islands consist of broadleaved evergreen hardwood species mainly of a West Indian distribution and are typically surrounded by pineland or wetland vegetative communities which occur in wetter soils (Tomlinson, 1980). The island-like character is most evident on mainland Monroe County, where raised areas among the pinelands and freshwater wetlands harbor hammock forests. In the Keys, the natural topographic configuration of the islands, especially in the Upper Keys, has favored development of large stands of hardwoods.

The drier climate and well-drained soils of the Keys relative to the mainland also allow establishment of well-developed stands of tropical hardwoods, to the virtual exclusion of temperate species. Hammock vegetation on the Keys may include a higher proportion of species which are rare on the mainland (e.g. Milbark, Drypetes diversifolia); Lignumvitae, Guaiacum sanctum; and Princewood, Exostema caribaeum) and many tropical species are restricted to the Keys (e.g., Pisonia, Pisonia rotundata; Maidenbush, Savia bahamensis; and Cinnecord, Acacia choriophylla) (Tomlinson, 1980). The soil of these hammocks consists mostly of a layer of partially decomposed organic matter resting directly on a porous limestone substrate. This humus layer allows an increased soil moisture relative to other vegetational communities in the Keys. Hammocks are a colonizing flora and many of the trees can grow without leaf litter, generating the layer themselves, and thus preparing the substrate for other species (Wayne Hoffman, pers. comm.). The closed canopy of hammocks is insulative, moderating thermal extremes (Olmstead and Loope, 1984) and reducing the loss of soil moisture.

Hurricanes also have had periodic impacts on hammocks which result in an interruption of hammock succession. This produces the effect of hammocks or parts of hammocks in various stages of succession. It is possible that certain characteristics and structural components of the hammock, such as the density or thickness of growth, and the high density of the wood of some tree species are adaptations to repeated hurricane impacts. Other characteristics include some seed dispersal by wind (although this is a relatively minor component) and the ability of some trees to root after having been toppled.

Hammocks have been subcategorized as high hammocks and low hammocks on the basis of their vegetation and structure. High hammocks occur on slightly elevated and drier ground, while low hammocks are typically on lower ground and usually have a substrate which may retain water longer than surrounding areas (Tomlinson, 1980). In the Keys, low hammocks occur at approximately one to two meters (3.3 to 6.6 feet) above sea level, and high hammocks occur a approximately two to five meters (6.6 to 16.4 feet) (Karen Achor in Monroe County, 1986a). Floristically, the two hammock types differ considerably, since the tolerance of trees to wet soil varies considerably. However, there is also a great deal of variation in floristic composition which seems independent of substrate conditions (Tomlinson, 1980).

Table 3.12 lists many of the species normally occurring in high and low hammocks along with their dominance as estimated by relative abundance in some representative hammocks. Although it is recognized that alternative measures of dominance exist, other than strict abundance, this listing serves as sufficient until further documentation is presented. A detailed and complete map of

hammocks on the Keys has not been completed to date. Some of the larger hammock systems have been documented as to location (Weiner, 1979; Kruer, 1991).

High Hammocks

High hammocks occur primarily in the Upper Keys and are rare elsewhere. A typical high hammock canopy ranges from four to ten meters (13 to 32.8 feet) with some taller trees protruding sometimes up to seven meters (23 feet) above the canopy. Some high hammocks will have smaller species forming a discontinuous understory or shrub layer, but generally the hammock understory is fairly open with ground covers being sparse due to shading.

Low Hammocks

Low hammocks tend to have smaller trees and a more densely-appearing forest structure. Structure may vary however, from a fairly open and easily passable understory as generally occurs on Key Vaca (Marathon) to an extremely dense canopy as low as two meters (6.5 feet) which is nearly impossible to penetrate such as occurs on parts of Upper Sugarloaf Key. Low hammocks may be further subcategorized on the basis of plant composition and/or substrate. Although many subcategories of low hammock, such as "stopper thicket" and "thorn scrub" or "scrub hammock" are locally recognized by biologists, only three categories have been documented and recognized. These include cactus hammock, palm hammock, and berm hammock types.

Cactus hammocks occur on Long Key and Big Pine Key (Weiner, 1979). These are low hammocks with understories and/or groundcovers dominated by cacti of the genera Opuntia and Cereus. While some species such as Barbed Wire Cactus, Cereus pentagonus, and Prickly Pear Cactus, Opuntia stricta (var. dillenii), are common in cactus hammocks, others such as Prickly Apple Cactus (Cereus gracilis, and Tree Cactus (Cereus robinii) are rare.

Palm hammocks are low hammocks which are dominated by the native palms Florida thatch palm (Thrinax radiata), Keys thatch palm (Thrinax morrisii), and possibly silver palm (Coccothrinax argentat). Palm hammocks are most common in the Middle Keys. Documented sites include various locations on Fat Deer Key, Grassy Key, and Key Vaca (Marathon).

Berm hammocks are low hammocks that develop on beach berms. They may be dominated by hardwoods or palms. They occur on many of the beach and berm communities through the Keys (see Beaches and Berms). Well developed berm hammocks may be seen on parts of Long Beach (Big Pine Key), Sugarloaf Beach, Boot Key Beach, Bahia Honda State Recreation Area Beach and others.

FNAI Inventory of Significant Undisturbed Tropical Hardwood Hammocks

The Florida Natural Areas Inventory (FNAI) has identified 50 sites in the Florida Keys (excluding Dade County and Key West) which are characterized by large tracts of undisturbed tropical hardwood hammock vegetation (see Table 3.13) (Kruer, 1991). These sites generally include parcels greater than 20 acres in size.

FNAI has identified these hammocks as the significant hammock remnants in the Keys. Because of their extremely limited distribution, these biological communities are considered by FNAI to be of state and national importance.

Table 3.12

Dominant Species of Representative High and Low Tropical Hardwood Hammock in the Florida Keys

Common Name	Species Name	Hammock	
		High	Low
Torchwood	*Amyris elemifera*	✓	✓
Marlberry	*Ardisia escallanioides*	✓	✓
Crabwood	*Ateramnus lucidus*	✓	✓
Saffron Plum	*Bumelia celastrina*		✓
Willow Bustic	*Bumelia salicifolia*	✓	✓
Gumbo Limbo	*Bursera simaruba*	✓	✓
Locustberry	*Byrsonima cuneata*		✓
Spicewood	*Calyptranthes pallens*	✓	
Wild Cinnamon	*Canella winterana*	✓	
Limber Caper	*Capparis flexuosa*		✓
Snowberry	*Chiococca alba*	✓	✓
Pigeon Plum	*Coccoloba diversifolia*	✓	✓
Buttonwood	*Conocarpus erectus*	✓	✓
Milkbark	*Drypetas diversifolia*	✓	
Black Torch	*Erithalis fruticosa*		✓
White Stopper	*Eugenia axillaris*	✓	✓
Spanish Stopper	*Eugenia foetida*	✓	✓
Everglades Velvetseed	*Cuettarda elliptica*	✓	
Black Ironwood	*Krugidendron ferreum*	✓	✓
Wild Lantana	*Lantana involucrata*	✓	✓
Wild Tamarind	*Lysiloma latisiliquum*	✓	
Wild Dilly	*Manilkara bahamensis*	✓	✓
Poisonwood	*Metopium toxiferum*	✓	✓
Myrsine	*Myrsine floridana*		✓
Lancewood	*Nectandrea coriacea*	✓	
Jamaican Dogwood	*Piscidia piscipula*	✓	✓
Cockspur	*Pisonia rotundata*		✓
Black Bead	*Pithecellobium guadalupense*	✓	✓
Long Stalked Stopper	*Psidium longipes*		✓
Wild Coffee	*Psychotria nervosa*	✓	
Indigo Berry	*Randia aculeata*		✓
Darling Plum	*Reynosia septentrionalis*		✓
Maidenbush	*Savia bahamansis*		✓
Bahama nightshade	*Solanum bahamense*		✓
Mahogany	*Swietenia mahogoni*	✓	
Tallowwood	*Ximenia americana*		✓
Wild Lime	*Zanthoxylum fagara*		✓

Source: Weiner, 1979.

Table 3.12

Dominant Species of Representative High and Low Tropical Hardwood Hammock in the Florida Keys

Common Name	Species Name	Hammock	
		High	Low
Torchwood	*Amyris elemifera*	✓	✓
Marlberry	*Ardisia escallanioides*	✓	✓
Crabwood	*Ateramnus lucidus*	✓	✓
Saffron Plum	*Bumelia celastrina*		✓
Willow Bustic	*Bumelia salicifolia*	✓	✓
Gumbo Limbo	*Bursera simaruba*	✓	✓
Locustberry	*Byrsonima cuneata*		✓
Spicewood	*Calyptranthes pallens*	✓	
Wild Cinnamon	*Canella winterana*	✓	
Limber Caper	*Capparis flexuosa*		✓
Snowberry	*Chiococca alba*	✓	✓
Pigeon Plum	*Coccoloba diversifolia*	✓	✓
Buttonwood	*Conocarpus erectus*	✓	✓
Milkbark	*Drypetas diversifolia*	✓	
Black Torch	*Erithalis fruticosa*		✓
White Stopper	*Eugenia axillaris*	✓	✓
Spanish Stopper	*Eugenia foetida*	✓	✓
Everglades Velvetseed	*Cuettarda elliptica*	✓	
Black Ironwood	*Krugidendron ferreum*	✓	✓
Wild Lantana	*Lantana involucrata*	✓	✓
Wild Tamarind	*Lysiloma latisiliquum*	✓	
Wild Dilly	*Manilkara bahamensis*	✓	✓
Poisonwood	*Metopium toxiferum*	✓	✓
Myrsine	*Myrsine floridana*		✓
Lancewood	*Nectandrea coriacea*	✓	
Jamaican Dogwood	*Piscidia piscipula*	✓	✓
Cockspur	*Pisonia rotundata*		✓
Black Bead	*Pithecellobium guadalupense*	✓	✓
Long Stalked Stopper	*Psidium longipes*		✓
Wild Coffee	*Psychotria nervosa*	✓	
Indigo Berry	*Randia aculeata*		✓
Darling Plum	*Reynosia septentrionalis*		✓
Maidenbush	*Savia bahamansis*		✓
Bahama nightshade	*Solanum bahamense*		✓
Mahogany	*Swietenia mahogoni*	✓	
Tallowwood	*Ximenia americana*		✓
Wild Lime	*Zanthoxylum fagara*		✓

Source: Weiner, 1979.

It should be noted that the North Key Largo Hammocks site (MONR-02) encompasses 1987 acres and includes a variety of successional stages and hammock types, previously mapped and described as many separate parcels (Weiner, 1979). The FNAI inventory treats it as a single large site due to physical and floristic similarities and the ability of native animals to move throughout it (Kruer, 1991).

B. Existing Commercial, Recreational, or Conservation Uses of Tropical Hardwood Hammocks

Since the 1950's, development in coastal uplands of the Keys has resulted in the loss of considerable acreage of tropical hardwood hammocks. This development has occurred throughout the Upper, Middle and Lower Keys and has involved all types of residential, commercial, institutional and government uses.

Today, there are approximately 7,000 acres of undisturbed tropical hardwood hammock remaining in the Keys (Monroe County BOCC, 1991a). Of these, approximately 6,360 acres (91 percent) are within 50 parcels, generally 20 acres or more in size (derived from Kruer, 1991). The other 640 acres are scattered throughout the Keys in a large number of smaller tracts.

Approximately 3,681 acres (58 percent) of the remaining significant tracts of tropical hardwood hammocks in Monroe County (excluding Key West) are protected through public or non-profit ownership for conservation purposes (derived from Kruer, 1991). Land acquisition efforts have focused in recent years on the higher quality hammocks. Today, approximately one-half (736 acres) of the remaining significant tracts of hammock rated "excellent" quality are protected (derived from Kruer, 1991).

Conservation lands (see Section 3.18) in the Keys which include significant hardwood hammock communities are summarized as follows (derived from Kruer, 1991):

Conservation Land	Acres of Significant Hammock Habitat
Crocodile Lake National Wildlife Refuge	approx. 541 ac.
Key Largo Hammocks State Botanical Site	approx. 1000 ac.
Lignumvitae Key State Botanical Site	147 ac.
DNR	147 ac.
National Key Deer Refuge	1297 ac.
John Pennekamp Coral Reef State Park	199 ac.
Long Key State Recreation Area	59 ac.
Great White Heron National Wildlife Refuge	31 ac.
Coupon Bight Aquatic Preserve	20 ac.
Windley Key State Geological Site	12 ac.
Key West National Wildlife Refuge	2 ac.
The Nature Conservancy	54 ac.

In addition to these conservation lands, DNR owns 147 acres of hammock on Fat Deer Key and the FWS owns 15 acres of hammock on Sugarloaf Beach (Kruer, 1991).

Table 3.13

Inventory of Remaining Significant Undisturbed Tropical Hardwood Hammocks

Site #	Site Name	Ranking	Size (acres)	Ownership			Public / Non-Profit Landowner
				Public	Private	Non-Profit	
MONR-01	Palo Alto	A	89	0	89	0	
MONR-02	North Key Largo Hammocks	A	1987	1541	446	0	Crocodile Lake National Wildlife refuge; Key Largo
MONR-05	El Radobob Hammocks	A	88	88	0	0	John Pennekamp Coral Reef State Park
MONR-14	Lignumvitae Key	A	147	147	0	0	Lignumvitae Key State Botanical Site
MONR-20	Fat Deer Key	A	147	147	0	0	Florida DNR
MONR-25	Little Pine Key	A	130	130	0	0	National Key Deer Refuge
MONR-27	No Name Hammock	A	390	337	53	0	National Key Deer Refuge
MONR-28	Howe Key	A	90	90	0	0	National Key Deer Refuge
MONR-29	Big Pine North	A	85	85	0	0	National Key Deer Refuge
MONR-30	Watson Hammock	A	94	94	0	0	National Key Deer Refuge
MONR-32	Cactus Hammock	A	60	56	4	0	National Key Deer Refuge
MONR-38	Big Torch Hammock	A	235	176	59	0	National Key Deer Refuge
MONR-40	Middle Torch Hammock	A	312	77	235	0	National Key Deer Refuge; private lands are within CARL Project - Hammocks of the Lower Keys
MONR-45	Little Knockemdown	A	163	0	163	0	Private lands are within CARL Project - Hammocks of the Lower Keys
Subtotal	**A-Rank Hammocks**		**4017**	**2968 (74%)**	**1049 (26%)**	**0 (0%)**	
MONR-03	North Sound Hammock	B	108	73	35	0	John Pennekamp Coral Reef State Park
MONR-06	South Sound Hammocks	B	58	38	20	0	John Pennekamp Coral Reef State Park
MONR-08	Rock Harbor	B	105	0	105	0	
MONR-09	Dove Creek Hammocks	B	118	0	118	0	
MONR-10	Tavernier Towne Hammocks	B	35	0	35	0	
MONR-13	Teatable Hammock	B	30	0	30	0	
MONR-17	Long Key Berms and Hammock	B	64	64	0	0	Long Key State Recreation Area; Monroe County Environmental Management (approx. 5 ac)
MONR-19	Long Point	B	60	0	60	0	
MONR-24	Little Johnson	B	15	15	0	0	Great White Heron refuge & National Key Deer Refuge
MONR-26	East Water Key	B	10	10	0	0	National Key Deer Refuge
MONR-34	Coupon Bight Hammock	B	40	20	20	0	Coupon Bight Aquatic Reserve
MONR-35	Big Munson	B	7	0	7	0	
MONR-37	Torchwood Hammock	B	40	0	0	40	The Nature Conservancy
MONR-39	Big Torch South	B	80	0	80	0	Private lands are within CARL Project - Hammocks of the Lower Keys
MONR-41	Ramrod Berms and Hammocks	B	147	0	147	0	Private lands are within CARL Project - Hammocks of the Lower Keys
MONR-42	Toptree Hammock	B	25	25	0	0	National Key Deer Refuge
MONR-43	Cupania Hammock	B	48	0	48	0	Private lands are within CARL Project - Hammocks of the Lower Keys
MONR-44	Knockemdown	B	50	50	0	0	National Key Deer Refuge
MONR-46	Cudjoe Hammocks East	B	118	107	11	0	National Key Deer Refuge; private lands are within CARL Project - Hammocks of the Lower Keys

Table 3.13

Inventory of Remaining Significant Undisturbed Tropical Hardwood Hammocks

Site #	Site Name	Ranking	Size (acres)	Ownership			Public / Non-Profit Landowner
				Public	Private	Non-Profit	
MONR-47	Cudjoe Hammocks West	B	89	89	0	0	National Key Deer Refige (53 acres) Monroe Co. Landfill; City of Key West Utility
MONR-48	Johnston Key Hammocks	B	16	16	0	0	Great White Heron National Wildlife Refuge
MONR-49	Sugarloaf Hammocks North		200	172	28	0	U.S.F.W.S.
MONR-52	Sugarloaf Beach		49	15	34	0	Monroe County School Board (not Protected)
MONR-56	Boca Grande Dunes and Hammocks	B	2	2	0	0	Key West National Wildlife Refuge
Subtotal	**B-Rank Hammocks**		**1514**	**696 (46%)**	**778 (51%)**	**40 (3%)**	
MONR-04	Largo Sound Village	C	39	0	39	0	
MONR-07	St. Margaret	C	127	0	127	0	
MONR-11	Plantation Hammock	C	70	0	70	0	
MONR-12	Windley Key Quarry	C	12	12	0	0	Windley Key State Geological Site
MONR-15	Lower Matecumbe Hammock	C	23	0	9	14	The Nature Conservancy
MONR-16	North Layton Hammock	C	10	0	10	0	
MONR-21	Marathon Airport Hammock	C	71	0	71	0	
MONR-31	Pinecrest	C	20	5	15	0	National Key Deer Refuge
MONR-36	Little Torch North	C	60	0	60	0	
MONR-50	Pirate's Cove	C	95	0	95	0	Two-thirds of private land are within CARL Project - Hammocks of the Lower Keys
MONR-51	Lower Sugarloaf Hammocks	C	248	0	248	0	Private lands are within CARL Project - Hammocks of the Lower Keys
MONR-22	Crane Point Hammocks	C	51	0	13	38	Florida Keys Land and Sea Trust
Subtotal	**C-Rank Hammocks**		**826**	**17 (2%)**	**757 (92%)**	**52 (6%)**	
Total	**All Hammocks**		**6357**	**3,681 (58%)**	**2,584 (70%)**	**92 (1%)**	

(1) Approximately 54 acres of hammock which are in public ownership are not considered protected.

(2) Not yet ranked.

[ ] Tropical hardwood hammocks which are owned and protected for conservation purposes.

Rankings
A - Excellent
B - Good
C - Fair
D - Poor

Rankings are based on degree of disturbance, degree of exotic plant invasion, species diversity, structural diversity, relative size, and the extent edges are intact. Entire sites are given the same rank even though quality may not always be consistent throughout a site. Protection of the high quality portion of a site is dependent on protection of the perimeter or buffer.

Source: Derived from Kruer, 1991 (prepared for the Florida Natural Areas Inventory).

A total of 2,584 acres of undisturbed hammock remain in private ownership. Of these, 995 acres (38 percent) are within the acquisition program for the Hammocks of the Lower Keys proposed CARL Project (derived from Kruer, 1991). This leaves approximately 1,589 acres of hammock in private ownership which are not part of the Hammocks of the Lower Keys CARL Project. Approximately 651 acres (41 percent) of these 1,627 acres are ranked as excellent quality hammock (derived from Kruer, 1991).

Approximately 54 acres of hammock which are in public ownership are not considered protected, as they are held by the Monroe County School Board, the Monroe County Municipal Services District, and the Utility Board of the City of Key West (derived from Kruer, 1991).

C. Known Pollution Problems and/or Issues Related to Tropical Hardwood Hammocks

Impacts that affect hammocks on the Keys are varied and include natural events such as hurricanes and fires. Man-induced impacts include activities such as land clearing, dredging, ditching, filling, and the introduction of exotic plants. The nature of these impacts depends on the integrity and size of the hammock. Recovery from the impacts depends on the condition, size, and amount of surrounding hammocks and wetlands, or the type of development on adjacent land.

Hurricanes are the most important natural force that impacts terrestrial ecosystems in the Keys. The degree of disturbance varies with hurricane intensity. Severe hurricanes can devastate hardwood hammocks so that many years or even decades may be required for recovery. Fires also can alter hammocks for long periods since they may destroy the shallow organic soil that is essential for the structure and function of the hammock ecosystem. Usually natural fires result from lightning strikes during the wet season when most humus is less likely to burn extensively. Following fire, successional changes will reestablish the species assemblage characteristic of the original system. This is attributable largely to the fact that such natural catastrophes are recurring phenomena to which species have evolved. The cumulative result of these adaptations generates a regular and orderly successional recovery following such events.

Man's impact to and disturbance of coastal uplands in the Keys has taken many forms, with both long-term and short-term impacts (Kruer, 1991). Disruptive land uses have historically included hardwood and buttonwood logging (for charcoal), and clearing for railroad beds, roads, agriculture, commercial and residential development and public facilities (Kruer, 1991). Other impacts have resulted from rock pit excavation, dredging of canals, mosquito ditches, plant theft, dumping (especially piles of vegetative and organic debris), mosquito spraying, and regular thinning or mowing of native groundcovers, shrubs and trees (Kruer, 1991).

Large-scale loss and alteration of hammocks has generally occurred on a larger scale in the Upper Keys (Kruer, 1991). Several hundred acres are estimated to have been lost since 1980 in the Upper Keys, including some of the most mature high hammock in North Key Largo (Kruer, 1991). Despite these losses, the most critical potential impact related to tropical hardwood hammocks is the tremendous potential for continued piecemeal loss of the Keys' natural habitats to single family residential development (Kruer, 1991).

Many of the remaining large tracts of tropical hardwood hammock documented by FNAI in the Upper Keys are ranked fair ("C") in quality usually as a result of disturbed edges, fragmentation, and

proliferation of exotic vegetation typically Brazilian pepper and Australian pine, all resulting from proximity to development (Kruer, 1991). With additional development and fragmentation these hammocks will continue to decline in quality (Kruer, 1991). An aggressive local program to remove invasive exotic plants could limit this disturbance and gradually restore values to these disturbed hammocks (Kruer, 1991).

Filling in uplands occurs for a variety of reasons including fill for roads, septic tank drainfields, and elevation of structures above flood levels. Because of the differences in substrate, it is likely that recolonization of abandoned fill sites will result in a species assemblage that differs from the biota of the original hammock.

Mosquito control activities also result in the degradation of hammocks. Mosquito ditches provide avenues for saltwater intrusion and invasion by exotics. Mosquito spraying may affect pollinators as well as mosquitos.

Road construction has seriously affected hammocks, both directly and indirectly. In addition to the direct destruction of hammock acreage, road construction dissects and fragments hammock systems. On North Key Largo, all hammocks are dissected by US 1 or C-905, most through (or close to the center of the hammock. The increased access thus provided to hammocks results in further indirect environmental damage by increasing storm damage, invasion of exotics, soil dessication, collecting, illegal dumping, fire and vandalism.

Removing the understory and ground cover from hammocks is becoming a common practice in the Keys. This practice of grubbing out provides visual access, increased airflow, and space for planted colorful exotics. This severely degrades hammocks by direct elimination of smaller plants (including the young of canopy species), reduction of wildlife habitat, and increased exposure to the desiccating influences of wind and light.

The extensive introduction of exotic plants further complicates the prospects of recovery from natural or human-caused impacts, since many of these tend to out compete and eventually replace some native species that are links in the seral recovery sequence that would otherwise generate a hammock climax. Brazilian Pepper, Australian pine and Asiatic colubrina are particularly prolific. In recent years these species have invaded virtually all sites on keys adjacent to US 1 (Kruer, 1991). While they typically have difficulty establishing themselves in unmodified hammocks, they rapidly invade altered hammock areas and may delay or even prevent recovery depending on the severity of disturbance. In part, the vulnerability of hammocks is attributable to the easily destroyed thin soil layer that is the edaphic foundation of its fragile trophic structure. This vulnerability is further attributable to the hammocks' isolation and discontinuity, which can make recruitment of successional forms difficult and thereby retard or prevent reestablishment of a hammock climax.

Brazilian pepper is a particular invasive species common on disturbed substrates and debris piles and whose seeds are easily spread by birds and mammals, even into the interior of some out-islands (Kruer, 1991). Initial colonization of disturbed sites by Brazilian pepper may be the primarily the result of largely illegal dumping of vegetative and land clearing debris (Kruer, 1991). Although requirements for removal of Brazilian pepper on private lands is now attached to Development Orders, problems of enforcement, long-term maintenance, and extensive undeveloped private lands with exotics limits effectiveness (Kruer, 1991).

D. Potential for Conservation, Use or Protection of Tropical Hardwood Hammocks

Public acquisition is the most expeditions means of protecting the remaining large tracts of tropical hardwood hammock in the Keys. Government acquisition of hardwood hammocks in the Keys began approximately 12 years ago. While these efforts have led to preservation of 3,681 acres of hammock, increased effort is required to protect further losses. Efforts are needed to coordinate and expand the ongoing acquisition activities of Monroe County, SFWMD, DNR, the U.S.FWS, and non-profit conservation organizations. At North Key Largo Hammocks, active acquisition programs by the state and federal governments are proceeding towards total acquisition of remaining 446 acres of privately-owned hammock at that site, as well as some developable, disturbed land (Kruer, 1991). Future funding efforts for acquisition should place priority on funding the acquisition program for the Hammocks of the Lower Keys CARL Project which encompasses 995 acres (39 percent) of the remaining significant hammocks in private ownership in Monroe County (derived from Kruer, 1991).

While public acquisition is likely to protect some of the most sensitive of the remaining tropical hardwood habitat, it is unrealistic to expect that adequate funds will become available to permanently protect all that remains in the Keys. In order to protect the lower quality and smaller remnants of hardwood hammock, it will be necessary to adopt land use policies and land development regulations which further protect these areas from loss, fragmentation, disruption of natural drainage, pollution, and invasive plants.

Future development in the County should be directed to the maximum extent possible away from high quality hammocks. This should be accomplished through land use policies of the Comprehensive Plan and its implementing land development regulations. Sites ranked "high quality" through application of the Habitat Evaluation Index (see below) should be considered to have low intrinsic suitability for development. In developing the Permit Allocation System for implementation of the Plan, consideration should be given to assigning a negative point to developments proposed in hammock which is ranked high quality by the Habitat Evaluation Index (see Future Land Use Element Section 2.4.1.B).

Monroe County currently utilizes a "Habitat Evaluation Index (HEI)" as a means of ranking the habitat value of low hammocks and high hammocks. This ranking is used to establish open space requirements and applicability of environmental design criteria, summarized as follows (Monroe County BOCC, 1990):

high hammock (high quality)	80 percent
high hammock (moderate quality)	60 percent
high hammock (low quality)	40 percent
low hammock (high quality)	80 percent
low hammock (moderate quality)	60 percent
low hammock (low quality)	40 percent

No refinements to these open space requirements are deemed necessary at this time.

While the open space requirements for hammock habitat continue to be appropriate, the Monroe County Biologist has recommended that revisions be made to the HEI procedure. These are

recommended to make the HEI procedure more scientifically defensible and ecologically meaningful. In particular, revisions are needed to more effectively discriminate among high, moderate and low quality low hammocks as well as high, moderate and low quality high hammocks.

Cactus hammocks and palm hammocks are not subject to the HEI; the open space requirements for these habitats is 90 percent, regardless of condition (Monroe County BOCC, 1990). Disturbed hammocks are also exempt from the HEI; the open space requirement is 20 percent (Monroe County BOCC, 1990). No refinements to these open space requirements are deemed necessary at this time. The Land Development Regulations (Monroe County BOCC, 1990) currently require clustering on the lowest quality habitat within a proposed development site until maximum allowable density is reached; further development must then occur on the next lowest quality habitat until maximum allowable density is reached, and so on. To prevent unnecessary fragmentation of sites which are characterized entirely by hardwood hammock vegetation, development permitted on the lowest quality habitat within the site should also be clustered within that portion of the site. Bulk regulations should also be revised to allow greater flexibility for clustering.

Clearing activities during construction frequently disturb areas outside of construction fences, sometimes affecting areas within required open spaces. Stronger clearing restrictions, coupled with site inspections and fines for violations of land development order conditions pertaining to clearing are required. Disturbances should not be permitted to the ground surface and vegetation within required open space areas.

In tropical hardwood hammocks on both public and private lands, there is a need for management activities focused on removal of invasive exotic species. Monroe County currently requires as a condition of development orders that invasive plants be removed from at least a portion of the development site. These conditions should be retained and expanded to the maximum extent legally possible. A county-wide program is also needed to restore and maintain disrupted native upland vegetation systems on public lands. Particular emphasis is needed on land management of private lands adjacent to public lands. Actions of private landowners which provide opportunities for colonization by invasive plants can compromise the management activities of the County as well as the FWS, DNR and other public and non-profit conservation organizations undertaking invasive plant removal on protected lands.

3.11.2 Pinelands

Pinelands, or "slash pinelands", are fire-climax systems dominated by pine trees. Although pinelands formerly existed in the Upper Keys (Alexander, 1953), their occurrence in Monroe County is presently limited to the Lower Keys, primarily on Little Pine Key, Big Pine Key, No Name Key, Cudjoe Key, Sugarloaf Key and on neighboring Keys (Weiner, 1979; Robertson, 1955).

The Comprehensive Plan Map Atlas includes maps showing the pinelands of the Lower Keys. These maps are available at a scale of 1"=2,000' and can be reviewed at the Monroe County Department of Planning.

A. Flora of Pinelands

The most extensive and best developed areas of pinelands remaining in the Keys occur on Big Pine Key. On Big Pine Key pinelands occupy most of the relatively high elevations on the interior of the island. They are comprised of a north and south section, the occurrence of which conforms quite closely with the outline of two underground freshwater lenses (Stewart et al., 1989). Recent evidence suggests that the occurrence of pinelands at a particular site is directly related to the presence of fresh groundwater (National Audubon Society, in preparation).

Pinelands are seral systems that are less easily characterized biotically than climax hardwood hammock. Caribbean Pine (Pinus elliottii var. densa) is the canopy dominant and Silverpalm (Coccothrinax argentata), Black-bead (Pithecellobium keyense) and the Keys Thatch Palm (Thrinax morrisii) are the primary midstory forms. Species composition of the understory is less easily characterized since it changes as succession progresses. Understory plants of rather general occurrence in pinelands are Long-stalked Stopper (Psidium longipes), Pisonia (Pisonia rotundata), and Locustberry (Byrsonima lucida). The ground cover consists of a large number of species including Golden Creeper (Ernodea littonalis), Sand Flax (Linum arenicola), Pine Pink (Bletia purpurea), Pine Fern (Anemia adiantifolia), Star Rush (Dichromena floridensis) and Andropogon virginicus.

Several endemic plant species of South Florida are found in the pinelands of the Keys, including (Avery and Loope, 1980):

Species	Habitat	Range
Argythamnia blodgettii	pinelands	Keys and mainland
Cassia keyensis	pinelands	endemic to Keys
Chamaesyce deltoidea var. serpyllum	pinelands	endemic to Keys
C. garberi	pinelands, hammocks, sand dunes	Keys and Mainland
C. porteriana var. keyensis	pinelands, sand dunes	endemic to Keys
C. porteriana var. scoparia	pinelands	Keys, possibly Big Cypress
Croton arenicola	pinelands, sand dunes	Keys and Mainland
Evolvulus sericeus var. averyi	pinelands	Keys and Mainland
Gerardia keyensis (Agalinis)	pinelands	endemic to Keys
Linum arenicola	pinelands	Keys and mainland
Melanthera parvifolia	pinelands	Keys and mainland
Phyllanthus pentaphyllys var. floridanus	pinelands	Keys and mainland
Schizachyrium sericatum	pinelands	endemic to Keys
Tragia saxicola	pinelands	Keys and mainland.

In the absence of fire, pineland understories tend to develop a subcanopy of hardwood species that eventually expands to replace the pine canopy. Ultimately pinelands succeed into hardwood hammocks - a process that may require about 50 years (Alexander and Dickson, 1972). This requires a build up of a wet humus layer that will not burn (Tomlinson, 1980). Hardwood hammock species which are early pioneers in the pinelands include species such as mahogany (Swietenia mahagoni) and poisonwood (Metopium toxiferum).

B. Existing Commercial, Recreational or Conservation Uses of Pinelands

Since the 1950's, development in coastal uplands of the Keys has resulted in the loss of considerable acreage of pinelands. On Big Pine Key alone losses are estimated at 50 percent in the last 50 years (Ross, 1989). Development in pinelands has involved all types of residential, commercial, institutional, and government uses.

Approximately 2200 acres of undisturbed pineland remain in the Keys (Monroe County BOCC, 1991a). Its occurrence is limited to Big Pine Key, Upper Sugarloaf Key, Cudjoe Key and No Name Key. Most development which has occurred in pineland is located on Big Pine Key. This primarily includes residential and commercial development.

Today, there are approximately 2,110 acres of undisturbed pineland remaining in the Keys (Monroe County BOCC, 1991a). Of these, approximately 1,370 (65 percent) are protected through public ownership for conservation purposes. Protected pinelands are located within the National Key Deer Refuge. Continued acquisition is planned by FWS as part of the Key deer movement corridor acquisition program (U.S.FWS, 1991a) and, to a more limited extent, by DNR as part of the Coupon Bight/Key Deer CARL Project (see Section 3.13.14).

C. Known Pollution Problems and/or Issues Related to Pinelands

Impacts that affect pinelands are varied and include natural events such as hurricanes and fires. Man-induced impacts include activities such as land clearing, dredging, ditching, filling, and the introduction of exotic plants. The nature of these impacts depends on the integrity and size of the pineland. Recovery from the impacts depends on the condition, size, and amount of surrounding pinelands, and the type of development on adjacent land.

Pinelands have adapted to hurricanes and fire, the principal natural disturbances in the Keys. If undisturbed, pinelands typically fully recover from such events. Fires are essential to the maintenance of pinelands. Consequently, fire exclusion in pinelands eventually generates a proliferation of hardwood species that culminates in a tropical hardwood hammock climax. Since humans discourage fire in the vicinity of habitations, development tends secondarily to reduce the extent of pinelands whose perpetuation entails periodic burning. In the absence of fire, a pineland in the Lower Keys may be replaced by hammock after about 50 years (Alexander and Dickson, 1972). The pinelands of some of the Lower Keys presently have almost succeeded to hardwood hammock. In the pinelands of Cudjoe Key there is a hardwood understory six meters or more high, while ground cover species typical of pinelands are absent.

The most damaging human impacts on pinelands occur when they are destroyed by clearing. Once cleared pinelands are unlikely to become reestablished on a development site. It is estimated that approximately one-half of the pinelands present on Big Pine Key in 1935 have been lost to development (Ross, 1989).

Indirect effects associated with drainage alterations and groundwater withdrawals may similarly damage pinelands. Impoundments within pinelands can drastically change the local soil moisture regime and cause the suffocation of roots and the corresponding death or dieback of plants. The occurrence of pinelands on Big Pine Key, and probably on other Keys, conforms quite closely with the outline of underlying freshwater lenses (Ross, 1989). Research in the Keys supports the hypothesis that this co-occurrence may not be a coincidence, and that the survival of the pinelands and associated freshwater marshes on Big Pine Key is dependent on maintaining the integrity of the freshwater resource (Ross, 1989). Wells penetrate the freshwater lenses on some keys, withdrawing water for agricultural and irrigation purposes. These withdrawals, combined with reductions in recharge brought about by accelerated surface drainage via canals and mosquito control ditches, serve to diminish the freshwater lenses and accelerate saltwater intrusion into them. If as research suggests, there is a functional connection between the pinelands and the freshwater resource, than it is possible that depletion of fresh groundwater lenses on Big Pine Key could cause a more rapid succession to hammock vegetation in the high pinelands, even with prescribed burning (Ross, 1989). At lower elevations this depletion could cause an increase in pine mortality due to direct exposure of roots to brackish water during spring tides, followed by replacement by a buttonwood community (Ross, 1989).

The introduction of invasive exotic plants is a serious problem in pineland communities, as it is in tropical hardwood hammocks (see Section 3.11.1.C).

D. Potential for Conservation, Use or Protection of Pinelands

Government acquisition of pinelands has preserved 1370 acres of pinelands in the Lower Keys. Some of the remaining 740 acres are funded for acquisition by the FWS and through funding from the CARL Program and the Save Our Rivers Program. Acquisition of the pinelands still in private ownership and not funded for acquisition on Big Pine Key, Upper Sugarloaf Key, Cudjoe Key and No Name Key would be the most effective means of protecting the remaining pinelands still in private ownership.

While public acquisition is likely to protect some of the most sensitive of the remaining pineland habitat, it is unrealistic to expect that adequate funds will become available to permanently protect all that remains in the Lower Keys. In order to protect these pinelands it will be necessary to adopt land use policies and land development regulations which further protect these areas from loss, fragmentation, disruption of natural drainage, pollution, and invasive plants.

Future development in the County should be directed to the maximum extent possible away from high quality pinelands. This should be accomplished through land use policies of the Comprehensive Plan and its implementing land development regulations. Sites ranked "high quality" through application of the Habitat Evaluation Index (see below) should be considered to have low intrinsic suitability for development. In developing the Permit Allocation System for implementation of the Plan, consideration should be given to assigning a negative point to

developments proposed in pineland which is ranked high quality by the Habitat Evaluation Index (see Future Land Use Element Section 2.4.1.B).

Monroe County currently utilizes a "Habitat Evaluation Index (HEI)" as a means of ranking the habitat value of low hammocks and high hammocks. This ranking is used to establish open space requirements and applicability of environmental design criteria, summarized as follows (Monroe County BOCC, 1990):

pinelands (high quality)	80 percent
pinelands (low quality)	60 percent.

No refinement to these open space requirements are deemed necessary at this time.

While public acquisition is likely to protect some of the most sensitive of the remaining pineland habitat, it is unrealistic to expect that adequate funds will become available to permanently protect all that remains in the Lower Keys. In order to protect these pinelands it will be necessary to adopt land use policies and land development regulations which further protect these areas from loss, fragmentation, disruption of natural drainage, pollution, and invasive plants.

Future development in the County should be directed to the maximum extent possible away from high quality pinelands. This should be accomplished through land use policies of the Comprehensive Plan and its implementing land development regulations. Sites ranked "high quality" through application of the Habitat Evaluation Index (see below) should be considered to have low intrinsic suitability for development. In developing the Permit Allocation System for implementation of the Plan, consideration should be given to assigning a negative point to developments proposed in pineland which is ranked high quality by the Habitat Evaluation Index (see Future Land Use Chapter Section 2.4.1.B).

Monroe County currently utilizes a "Habitat Evaluation Index (HEI)" as a means of ranking the habitat value of low hammocks and high hammocks. This ranking is used to establish open space requirements and applicability of environmental design criteria, summarized as follows (Monroe County BOCC, 1990):

pinelands (high quality)	80 percent
pinelands (low quality)	60 percent.

No refinements to these open space requirements are deemed necessary at this time.

While the open space requirements for pinelands continue to be appropriate, the Monroe County Biologist has recommended that revisions be made to the HEI procedure. These are recommended to make the HEI procedure more scientifically defensible and ecologically meaningful. In particular, revisions are needed to more effectively discriminate among high and low quality pineland. (Disturbed pinelands are exempt from the HEI; the open space requirement is 20 percent (Monroe County BOCC, 1990). No refinement to this open space requirement is deemed necessary at this time.)

The Land Development Regulations (Monroe County BOCC, 1990) currently require clustering on the lowest quality habitat within a proposed development site until maximum allowable density is reached; further development must then occur on the next lowest quality habitat until maximum allowable density is reached, and so on. To prevent unnecessary fragmentation of sites which are characterized entirely by pineland, development permitted on the lowest quality habitat within the site should also be clustered within that portion of the site. Bulk regulations should also be revised to allow greater flexibility for clustering.

Clearing activities during construction frequently disturb areas outside of construction fences, sometimes affecting areas within required open spaces. Stronger clearing restrictions, coupled with site inspections and fines for violations of land development order conditions pertaining to clearing are required. Disturbances should not be permitted to the ground surface and vegetation within required open space areas.

In pinelands on both public and private lands there is a need for management activities focused on removal of invasive exotic species. Monroe County currently requires as a condition of development orders that invasive plants be removed from at least a portion of the development site. These conditions should be retained and expanded to the maximum extent legally possible. A county-wide program is also needed to restore and maintain disrupted native upland vegetation systems on public lands. Particular emphasis is needed on land management of private lands adjacent to public lands. Actions of private landowners which provide opportunities for colonization by invasive plants can compromise the management activities of the County as well as the FWS, DNR and other public and non-profit conservation organizations undertaking invasive plant removal on protected lands.

3.12 Wildlife

The Florida Keys encompass a variety of ecologically unique biological communities providing habitat to diverse wildlife populations, including many species endemic to the Keys, several of which are globally rare and endangered. As discussed above, the biological communities of the Keys include:

Living Marine Resources:

* mangrove forests along the shorelines of the Keys
* seagrass beds lying on both sides of the Keys and extending offshore to the Florida Reef Tract
* coral communities of nearshore and offshore waters, including the Florida Reef Tract

Wetlands:

* transitional wetlands lying landward of the mangrove fringe and seaward of upland communities
* beach/berms
* salt ponds occupying shallow enclosed basins having very restricted tidal influence
* small freshwater wetlands in areas of freshwater lenses in the Lower Keys

Uplands:

* tropical hardwood hammocks, the climax terrestrial community
* pinelands, a fire-climax system.

3.12.1 Wildlife of the Biological Communities of the Florida Keys

A. Wildlife Typically Inhabiting Mangrove Communities

The mangrove communities of the Keys provide food, cover, spawning, nesting and resting habitat for many species of mammals, birds, reptiles, amphibians, fish and invertebrates. Many of these species are dependent upon these communities during all or part of their life cycle.

A number of food webs are based on primary production of the mangroves and their associated epiflora. Energy flows stemming from mangrove-derived carbon begin their movement through these food webs as detritus, dissolved organic compounds, or as the products of direct grazing. Other pathways involve bacteria, fungi, macroalgae and phytoplankton associated with mangroves.

A variety of insects and gastropods graze directly upon arboreal leaf material. Simberloff and Wilson (1969) list 200 species of insects that are associated with mangrove communities. Snails (Littorina sp., Cerithidea sp. and Melampus sp.), isopods (Ligea spp.), and fiddler crabs (Uca spp.) are especially plentiful on the forest floor (Odum et al., 1982).

Mangrove communities also provide feeding, nesting and roosting habitat for numerous wading and fish eating birds. Odum et al. (1982) provides a list of 181 species of birds that use mangroves in South Florida. Among these, the following species are a major component of the avifauna of the Keys:

Great Egret	Casmerodius albus
Snowy Egret	Egreta thula
Great White Heron	Ardea herodias occidentalis
Great Blue Heron	Ardea herodias
Reddish Egret	Dichromanassa rufescens
Tricolored Heron	Hydranassa tricolor
Green Heron	Butorides striatus
Black-crowned Night Heron	Nycticorax
Yellow-crowned Night Heron	Nycticorax violcea
White Ibis	Eudocimus alba
Roseate Spoonbill	Ajaia ajaja
Double-crested Cormorant	Pyalacrocorax auritus
Magnificent Frigatebird	Fregata magnificens
Osprey	Paudion haliaetus
Mangrove Cuckoo	Coccyzus minor
Kingbirds	Tyranus spp.
Black-whiskered Vireo	Vireo altiloquus
Warblers	Dendroica spp.

All of these species nest in mangroves, usually on overwash islands.

A number of terrestrial and aquatic reptiles, amphibians and mammals utilize mangrove habitat. Of the several species of marine turtles that inhabit mangroves, the Atlantic Loggerhead (Caretta) is relatively common and may use mangroves as nursery areas (Odum et al, 1982). The Atlantic Hawksbill (Eretmochelvs imbricata) and the Atlantic Green Turtle (Chelonia mydas) are known to feed upon mangrove roots and leaves (Ernst and Barbour, 1972; Carr and Goin, 1955). Other reptiles include several species of snakes and anoles, and the Mangrove Terrapin. Of the snakes, only one, the Mangrove Water Snake (Nerodia fasciata compressicauda) is entirely dependent upon mangrove areas (Florida DNR, 1991c). Amphibians which inhabit mangroves include those which are suitably adapted to reproduce during brief rainy periods and/or which can use brackish pools for reproduction. Two introduced species, the Giant Toad (Bufo marinus) and the Cuban Treefrog (Hyla septentrionalis) have expanded their range considerably in mangrove areas in the last several decades (King and Krakauer, 1966; King and Krakauer 1968; and Krakauer, 1970).

Mammals which most commonly inhabit mangrove association include the Virginia Opossum (Didelphis virginian) and the Raccoon (Procyon lotor). Generally the opossum is confined to small populations in close proximity to human habitations. Both species are extremely versatile omnivores and are known to forage mangrove habitats (Layne, 1974). Other naturally occurring and introduced mammals which may frequent mangroves include the marsh rabbit (Sylvilagus palustis paludicola) and several species of rodents.

The most diverse group of organisms inhabiting the mangrove association are the marine organisms. Detritus and plankton are primary food sources for a large number of invertebrate fauna that attach themselves to prop roots, live in adjacent muds, or swim in the water (Florida DNR, 1991c).

B. Wildlife Typically Inhabiting Salt Marsh and Buttonwood Wetland Communities

Transitional wetlands support a fauna somewhat different from that of mangrove systems, although a number of animals feed in both tidal areas. The most frequently observed invertebrates are various species of insects, molluscs and crustaceans. The Fiddler Crab (Uca spp.) is often found where there is adequate soil for burrowing. The White Peanut Snail (Cerion spp.) is often found in large numbers on the marsh floor or climbing through the low-lying vegetation. Ram's Horn Snails and the gastropods Cerithidea and Melampus are also very common in the marsh.

A number of reptiles and mammals rely on transitional wetlands habitat. Of these, several are designated as rare, endangered or of special state concern, including:

Key Deer	Odocoilius virginianus clavium
Silver Rice Rat	Oryzomys argentatus
Lower Keys Rabbit	Sylvilagus palustris hefneri
Red Rat Snake	Elapha guttata.

The importance of Keys' transitional wetlands to wading bird populations has long been recognized by wildlife biologists. Virtually every wading bird species resident in the Keys forages in tidal wetlands. These birds rely on the shallow water areas of the transitional wetlands for feeding during

periods of the year when they are unable to feed in their usual feeding areas because the water is too deep for wading. During these periods, the undisturbed transitional wetlands are critical to the survival of many bird species. Among the most common wading birds that feed in transitional wetlands are:

Roseate Spoonbill	Ajaja
Great White Heron	Ardea heriodias occidentalis
Great Egret	Casmerodius albus
Little Blue Heron	Egretta caerulea
Snowy Egret	Egretta thula
Reddish Egret	Egretta rufescens
Tricolored Heron	Egretta tricolor
Green-backed Heron	Butoredes veresceus
White Ibis	Eudocimus albus
Black-crowned Night Heron	Nycticorax
Yellow-crowned Night Heron	Nycticorax violacea
Glossy Ibis	Plegadis falcinellus.

C. Wildlife Typically Inhabiting Salt Pond Communities

Salt pond fauna is diverse when compared to its depauperate flora. Racoons, insects, snakes and a great diversity of migratory and resident birds utilize the food resources of salt ponds. Within the ponds there is a variety of small fish, crustaceans and mollusks. Mollusks found in considerable abundance include species of the genera Cerithium and Modulus. (See Section 3.14 for a brief list of fish species common to salt pond communities.)

Birds known to use salt ponds as feeding habitat include:

Great Blue Heron	Ardea herodias
Great White Heron	A. herodias
Great Egret	Casmerodius albus
Snowy Egret	Egretta thula
Little Blue Heron	E. tricolor
Tricolored Heron	E. tricolor
Yellow-crowned Night Heron	Nycticorax violacea
Reddish Egret	Egretta rufescens
White Ibis	Eudocimus albus
Roseate Spoonbill	Ajaja
Black-bellied Plover	Pluvialis squatarola
Semipalmated Plover	C. semipalmatus
Willet	Catoptrophorus semipalmatus
Western Sandpiper	C. mauri
Dunlin	C. alpina
Short-billed Dowitcher	Limnodromus griseus
Brown Pelican	Pelecanus occidentalis
Laughing Gull	Larus atricilla
Ring-billed Gull (winter only)	L. delawarensis

Herring Gull (winter only)	L. argentatus
Common Tern	Sterna hirundo
Royal Tern	Sterna maxima
Forster's Tern (winter only)	S. forsteri
Lesser Yellowlegs	Totanus flavipes
Greater Yellowlegs	Totanus melanoleucus
Blue-winged Teal	Anas discors
Green Heron	Butorides striatus.

Several species of migratory waterfowl are also known to utilize salt ponds seasonally. Species of Fundulus, Cyprinodon, and Poecilia are the primary food fishes of the rare Roseate Spoonbill (Eudocimus alba)(Ogden, in Pritchard, v.2, 1978) and the White Ibis (Ajaja)(Kushlan, 1979). Similarly the rare Reddish Egret (Egretta rufescens) is reported to feed primarily on Killifish.

D. Wildlife Typically Inhabiting Freshwater Wetland Communities

Freshwater marshes normally support a highly diverse and abundant fauna that includes fish, invertebrates, amphibians, reptiles, mammals and birds. Many of these species, while more common elsewhere in Florida, are relatively rare in the Keys, largely because of the absence of freshwater resources. During the dry season these marshes are the only natural sources of water for wildlife in the area. They are particularly critical to the reproductive success of animal populations that bear young during the dry season.

A partial list of vertebrates (excluding birds) associated with freshwater and non-tidal wetlands on Big Pine Key is included in Table 3.14. Many of the vertebrate and invertebrate fauna listed are locally adapted forms that are biologically distinct and geographically restricted.

An abundant and varied bird population utilizes the freshwater wetlands. In addition to wetland species that are resident in the Keys, a diverse population of migratory bird species utilizes the wetlands and adjacent uplands on a seasonal basis. Sixty-seven species of birds are known to utilize habitat in the freshwater marshes of Big Pine Key (Jackson, 1989). Of these, 43 species are typically resident populations, and 24 species are migratory populations usually present only during winter months. Nine birds species ranked as endangered, threatened or species of special concern occur, including six species found commonly in the marshes and three which are typically rarely present, as follows:

Glossy Ibis	Plegadis falcinellus	Rare
Roseate Spoonbill	Ajaia ajaja	Rare
Reddish Egret	Egretta rufescens	Rare
Snowy Egret	Egretta thula	Common
Tricolored Heron	Egretta tricolor	Common
Least Tern	Sterna albifrons	Common
Caspian Tern	Hydroprogne caspia	Common
Bald Eagle	Haliaeetus leucocephalus	Common
White crowned Pigeon	Columba leucocephala	Common

Table 3.14

Partial List of Vertebrates (Excluding Birds) Associated with Freshwater and Non-Tidal Wetlands on Big Pine Key

Common Name	Species Name
Mammals	
Lower Keys cotton rat (1)	*Sigmodon hispidus exsputus*
Lower Keys rabbit (1)	*Sylvilagus palustris hefneri*
Lower Keys raccoon	*Procyon lotor incautus*
Key deer	*Odocoileus virginianus clavium*
Reptiles	
American Alligator (1)	*Alligator mississippiensis*
Striped mud turtle (1) (2)	*Kinosternon baurii*
Florida box turtle	*Terrapene carolina baurii*
Peninsular cooter (3)	*Pseudemys floridana peninsularis*
Chicken turtle (3)	*Deirochelys reticularia*
Florida softshell (3)	*Trionyx ferox*
Common snapping turtle	*Chelydra serpentina*
Black racer	*Coluber constrictor*
Eastern indigo snake (1)	*Drymarchon corais couperi*
Florida brown snake (1) (2)	*Storeria dekayi victa*
Rough green snake	*Opheodrys aestivus carinatus*
Key ringneck snake (1)	*Diadophis punctatus acricus*
Mangrove water snake	*Nerodia clarkii compressicauda*
Red rat snake (1) (2)	*Elaphe guttata guttata*
Florida ribbon snake (1) (2)	*Thamnophis sauritus sackenii*
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*
Amphibians	
Oak toad	*Bufo quercicus*
Southern toad	*Bufo terrestris*
Green treefrog	*Hyla cinerea*
Squirrel treefrog	*Hyla squirella*
Little grass frog	*Limnaoedus ocularis*
Cuban treefrog (3)	*Osteopilus septentrionalis*
Narrow-mouthed toad	*Gastrophryne carolinensis*
Southern leopard frog	*Rana utricularia*
Greenhouse frog (3)	*Eleutherodactylus planirostris*
Fishes	
Southern Gulf killfish	*Fundulus grandis saguanus*
Bluegill	*Lepomis macrochirus*
Cichlid (3)	*Cichlasoma cyanoguttatum*
Diamond Killifish	*Adinia xenica*
Mosquitofish	*Gambusia holbrookii*
Rainwater killifish (2)	*Lucania parva*
Sailfin molly (2)	*Poecilia latipinna*
Sheepshead killifish (2)	*Cyprinodon variegatus*

(1) Species designated rare, endangered or of special state concern.
(2) Listings and statuses refer to distinctive Lower Keys populations.
(3) Species not native to Big Pine Key (i.e., introduced).

Source: The Nature Conservancy, 1989.

E. Wildlife Typically Inhabiting Beach/Berm Wetland Communities

A variety of terrestrial wildlife is associated with the beach and berm community. Beaches provide nesting areas for a variety of shorebirds, primarily terns, as well as important feeding areas for a variety of shorebirds. Invertebrates, such as insects, amphipods, isopods, crabs, mollusks and worms, which are food for shorebirds, utilize accumulated seaweed and other organic beach debris as habitat. Sea turtles have always been associated with the Florida Keys, particularly with the beaches of the Dry Tortugas.

F. Wildlife Typically Inhabiting Tropical Hardwood Hammock Wetland Communities

The environment provided by the flora of tropical hardwood hammocks is a major determinant of the assemblage of animal species that inhabit these communities. Because of their uniqueness and restricted occurrence, tropical hardwood hammocks provide habitat for many endemic or very restricted species, including several species listed as rare, endangered or of special concern.

While amphibians are not abundant in Keys hammocks, many reptiles may be found. These include the Box Turtle (Terrapene carolina bauri), Key Mud Turtle (Kinosternon bauri), the endemic Keys Mole Skink (Eumeces egregius), Coral Snake (Micrurus fluvius), Eastern Diamondback Rattlesnake (Crotalus adamanteus), Key Ringneck Snake (Diadophis punctatus acricus), Eastern Indigo Snake (Drymarchon corais couperi), Florida Brown Snake (Storeria dekayi victa), Miami Black-headed Snake (Tantilla oolitica), the Florida Ribbon Snake (Thamnophis sauritus sackeni) and the Rosy Rat Snake (Elaghae guttata). While some of these reptiles apparently occur throughout the Keys, others are restricted to only a few Keys, such as the coral snake which is limited to the Upper and Middle Keys.

Many species of birds use tropical hardwood hammocks. Those known to nest in Keys hammocks are:

Red-shouldered Hawk	Buteo lineatus
Osprey	Pandion haliaetus
Mourning Dove	Zenaidura macroura
Ground Dove	Columbigallina passerina
Mangrove Cuckoo	Coccyzus minor
Yellow-billed Cuckoo	Coccyzus americanus
Screech Owl	Otus asio
Chuck Will's Widow	Caprimulgus carolinensis
Pileated Woodpecker	Dryocopus pileatus
Common Flicker	Colaptes auratus
Red-bellied Woodpecker	Centurus carolinus
Gray Kingbird	Tyrannus dominicensis
Great-crested Flycatcher	Myiarchus crinitus
Carolina Wren	Thryothorus ludavicianus
Mockingbird	Mimus polyglottus
Brown Thrasher	Toxostoma rufum
White-eyed Vireo	Vireo griseus
Black-whiskered Vireo	Vireo altiloguus
Red-winged Blackbird	Agelaius phonicius

Common Grackle	Quiscalus quiscula
Cardinal	Richmondena cardinalis.

Within the Keys, the range of some of these bird species is quite limited. The pileated woodpecker and Carolina wren, for instance, are known only from Key Largo.

Mammals that use Keys' tropical hardwood hammocks include the following:

Opossum	Dildelphis marsupialis
Gray Squirrel	Sciurus carolinensis matecumbei
Racoon	Procyon lotor
Marsh Rabbit	Sylvilagus palustris hefneri
Hispid Cotton Rat	Sigmodon hispidus
Least Shrew	Cryptotis parva
Bobcat	Felis rufus
Key Largo Wood Rat	Neotoma floridana smalli
Key Largo Cotton Mouse	Peromyscus gossypinus allapaticola
Key Vaca Raccoon	Procyon lotor auspicatus
Key Deer	Odocoileus virginianus clavium.

G. Wildlife Typically Inhabiting Pineland Communities

Pinelands are utilized as habitat of many animal species, including several forms endemic to the Keys. Endemic reptiles that use the pinelands include:

Key Mole Skink	Eumeces egregius
Key Ringneck Snake	Diadophis punctatus acricus
Florida Brown Snake	Storeria dekayi victa
Florida Ribbon Snake	Thamnophis sauritus sackeni.

The American Alligator (Alligator mississippiensis) uses pinelands as corridors between freshwater holes. Much of the Key deer (Odocoileus virginianus clavium) habitat includes pinelands.

H. Offshore Island Bird Rookeries

The backcountry area of Florida Bay contains a large number of bird rookeries, mostly on isolated mangrove islands. These islands are used by a variety of wading birds, shorebirds and marine turtles, including several species designated by the State and/or FWS as threatened, endangered or of special concern.

The Great White Heron National Wildlife Refuge and the Key West National Wildlife Refuge were established to protect many of these islands, recognizing their wildlife habitat. Approximately 60 islands, not connected by US 1, in the Keys remain in private ownership. These range in size from one acre to several hundred acres. An additional unknown number of offshore islands in Keys' waters are sovereignty lands owned by the State of Florida. A partial inventory of offshore island bird rookeries is mapped on the Protected Animal Species Map, included in this Comprehensive Plan by reference in Policy 205.2.12. Offshore islands which are designated as known habitat for any of the endangered or threatened nesting birds are rookeries.

Issues related to offshore islands in the Keys focus on the nature of permitted development uses on private lands and conflicts among user groups on publicly-owned islands (see Land Use Element Section 2.1.4).

Protection of wildlife habitat on offshore islands should be accomplished by a prohibition of development on all offshore islands documented as rookeries. The offshore islands designated as known habitat for nesting birds indicated on the protected Animal Species Map should be immediately prohibited from development. The list of islands which are considered rookeries should then be updated by the Monroe County Biologist in cooperation with the National Audubon Society Research Department, NPS, NOAA, FGFWFC, DNR and FWS. Sand beaches on offshore islands which are used by marine turtles would be subject to the Environmental Design Criteria of the Land Development Regulations (Monroe County BOCC, 1990) applicable to beach/berms (see Section 3.10.4 and 3.10.8).

3.12.2 Existing Commercial, Recreational and Conservation Uses of Florida Keys Biological Communities

Existing uses in each of the biological communities in the Keys are generally discussed in preceding sections of the Conservation and Coastal Management Chapter, as follows:

Section 3.8.1.B	Mangroves
Section 3.8.2.C	Seagrass Beds
Section 3.8.3.B	Coral Communities
Section 3.9.4.B	Salt Marsh and Buttonwood Wetlands (transitional wetlands)
Section 3.9.6.B	Salt Ponds
Section 3.9.7.B	Freshwater Wetlands
Section 3.10.3	Beach/Berms
Section 3.11.1.B	Tropical Hardwood Hammocks
Section 3.11.2.B	Pinelands
Section 3.12.1.G	Offshore Islands.

3.12.3 Known Pollution Problems and/or Issues Related to Wildlife Communities

Problems and issues related to wildlife in the Keys can be categorized as follows:

(a) destruction or modification of habitat;

(b) predation and/or destruction of native wildlife populations;

(c) direct and indirect disturbances caused by human activities which alter the distribution and behavior of native wildlife populations.

Destruction and modification of habitat has occurred in every biological community in the Keys. The known pollution problems and/or issues related to each community are discussed in preceding sections of the Conservation and Coastal Management Chapter, as follows:

Section 3.8.1.C	Mangroves
Section 3.8.2.D	Seagrass Beds
Section 3.8.3.C	Coral Communities
Section 3.9.4.C	Salt Marsh and Buttonwood Wetlands (transitional wetlands)
Section 3.9.6.C	Salt Ponds
Section 3.9.7.C	Freshwater Wetlands
Section 3.10.4 and 5	Beach/Berms
Section 3.11.1.C	Tropical Hardwood Hammocks
Section 3.11.2.C	Pinelands
Section 3.12.1.G	Offshore Islands.

In general, habitat losses and degradation include the following:

(a) loss of wetland and upland habitats to development

(b) degradation of nearshore water environments due to dredge and fill, water pollution, and recreational boating activities

(c) habitat contamination due to widespread aerial application of mosquito control chemicals.

Predation and/or destruction of native wildlife occurs as a result of a variety of factors, many of which are common to all habitat types. These include:

Natural Destruction:
* hurricanes
* fires

Predation by Native Populations:
* nesting site predation, particularly by raccoons
* hatchling predation, particularly by raccoons
* adult predation

Predation by Non-Native Wildlife Populations:
* nest destruction by free-roaming pets
* destruction of young and adults by free-roaming pets

Predation by Humans:
* egg collecting
* deliberate nest destruction
* deliberate human persecution (shooting/trapping/vandalism)
* commercial exploitation for the pet trade
* overcollection
* poaching

Accidental Death:

* boat collisions
* incidental catch, particularly due to net fishing in Florida Bay
* entanglement in fishing gear
* highway mortality, particularly along the "eighteen mile stretch" segment of US 1, Card Sound Road and in Big Pine Key
* accidental drowning in artificial waterbodies (canals and mosquito control ditches)

Activities Altering Distribution and Behavior:

* hand feeding resulting in loss of fear for man and vehicles
* human disturbances during courtship and nesting periods.
* installation of fencing
* general human harassment on land (by residents and visitors) and on the water (by divers, boaters, swimmers, fishermen and snorkelers).

3.12.4 Potential for Conservation, Use or Protection of Wildlife Communities

The potential for conservation, use or protection of habitat in each of the biological communities in the Keys are discussed in preceding sections of the Conservation and Coastal Management Chapter, as follows:

Section 3.8.1.D	Mangroves
Section 3.8.2.E	Seagrass Beds
Section 3.8.3.D	Coral Communities
Section 3.9.4.D	Salt Marsh and Buttonwood Wetlands (transitional wetlands)
Section 3.9.6.D	Salt Ponds
Section 3.9.7.D	Freshwater Wetlands
Section 3.10.8	Beach/Berms
Section 3.11.1.D	Tropical Hardwood Hammocks
Section 3.11.2.D	Pinelands
Section 3.12.1.G	Offshore Islands.

Other actions which could be taken by Monroe County to generally protect its wildlife populations include the following:

* adoption of a requirement for an environmental impact assessment for all major development proposals (see Section 3.13.2.C below)
* revisions to the Habitat Evaluation Index in the current Land Development Regulations (Monroe County BOCC, 1990) to better reflect the abundance and diversity of wildlife populations on development sites in pinelands and tropical hardwood hammocks
* revisions to the clustering requirements of the Land Development regulations (Monroe County BOCC, 1990) to prevent unnecessary fragmentation of native upland sites
* prohibition of development on offshore islands documented as bird rookeries
* establishment of a one-hundred (100) percent open space requirement for undisturbed salt marsh and buttonwoods
* stepped-up enforcement of animal control laws (see Section 3.13.2.F below)
* stepped-up enforcement of animal feeding laws

* adoption of an exotic wildlife species ordinance (see Section 3.13.2.G below).

3.13 Threatened and Endangered Species

3.13.1 Occurrences of Threatened and Endangered Species

Biological communities in the Florida Keys have evolved in response to unique island environmental conditions characterized by salt water, hot sun, dry seasons and hurricanes. Extreme environmental conditions combined with the isolation of the island archipelago have supported colonization and evolution of highly specialized plants and animals. Today, many are endemic to the Keys; others are limited to a relatively small geographic area on this continent. Populations of species in the Keys have evolved to the point of representing unique races or subspecies, existing nowhere else in the world (Ross, 1989).

Vertebrates of the Florida Keys largely represent a subset of those species that occur in temperate mainland North America, particularly the Florida Peninsula (Ross, 1989). In contrast, the plants of the Florida Keys exhibit a substantial floral component derived from the tropics (Lazell, 1984).

Two major focal points exist for the unique forms of vertebrates and plants in the Florida Keys: Key Largo and Big Pine Key (Ross, 1989). These are the two largest keys, possessing the greatest diversity and habitat area (Ross, 1989). Big Pine Key also is characterized by the only extensive perennial freshwater resources for wildlife (Ross, 1989).

Table 3.15 presents a list of species designated as endangered, threatened or of special concern by the following organizations:

(a) Florida Game and Fresh Water Fish Commission;

(b) Florida Department of Agriculture;

(c) Fish and Wildlife Service; and

(d) Convention on International Trade in Endangered Species of Wild Fauna and Flora.

A total of 45 vertebrates, 4 invertebrates and 82 plants are listed. Table 3.15 generally identifies the types of habitat typically used by each species for feeding, resting and nesting, as well as the approximate range for each species within the Keys.

Those species listed as threatened or endangered by the U.S. Fish and Wildlife Service (U.S.FWS) which are known to inhabit the Florida Keys include the following:

Species Designated as Endangered by the FWS

Atlantic Green Turtle	Chelonia mydas
American Crocodile	Crocodylus acutus
Leatherback Turtle	Dermochelys coriacea
Atlantic Hawksbill Turtle	Eretmochelys imbricata
Atlantic Ridley Turtle	Lepidochelys kempi

Southern Bald Eagle	Haliaeetus leucocephalus
Wood Stork	Mycteria americana
Bachman's Warbler	Vermivora bachmanii
Key Largo Wood Rat	Neotoma floridana smalli
Key Deer	Odocoileus virginianus clavium
Silver Rice Rat	Oryzomys argentatus
Key Largo Cotton Mouse	Peromyscus gossypinus allapoticola
Lower Keys Marsh Rabbit	Sylvilagus palustris hefneri
Florida Manatee	Trichechus manatus latirostris
Schaus' Swallowtail Butterfly	Heraclides aristodemus ponceanus
Tree Cactus	Cereus robinii
Small's Milkpea	Galactia smallii

Species Designated as Threatened by the FWS

American Alligator	Alligator mississippiensis
Atlantic Loggerhead	Caretta
Eastern Indigo Snake	Drymachron corais couperi
Piping Plover	Charaduius melodus
Arctic Peregrine Falcon	Falco peregrinus tundrius
Roseate Tern	Sterna dougallii
Stock Island Tree Snail	Orthalicus reses
Garber's Spurge	Euphorbia garberi.

The Comprehensive Plan Map Atlas includes Natural Features maps showing documented sightings, total known range and/or concentrated range within the Upper, Middle and Lower Keys, for 15 state or federally-designated vertebrates and invertebrates. Species for which this information is included are so noted in Table 3.15.

Monroe County has since updated the mapping of threatened and endangered animals with the "Protected Animal Species Map Series," completed in June 1992. The updated maps include the data which has been accumulated over the last five years, and depicts the range, known habitat, probable habitat, and/or potential habitat for 24 animal species listed as threatened or endangered. The updated information was obtained primarily from the Florida Game and Fresh Water Fish Commission's draft maps entitled, "Important Wildlife Habitats of the Florida Keys," dated April 7, 1992. The updated maps are based upon the latest official list of threatened and endangered animal species designated by the applicable state and federal agencies, which was dated April 1, 1991. These updated maps, and the corresponding table of species codes, are incorporated by reference into this Comprehensive Plan, and are available for review through the Environmental Resources Department.

For the remaining threatened or endangered vertebrates and invertebrates, either data are not available or information is not shown to protect the species from disturbance.

The occurrences of 14 state or federally-designated threatened and endangered plants are mapped at 1'=2,000'. These maps are available for review at the Monroe County Department of Planning. Table 3.15 indicates species for which occurrences are mapped. Other plants are not mapped due to lack of available data or information is not shown in order to protect the species from disturbance.

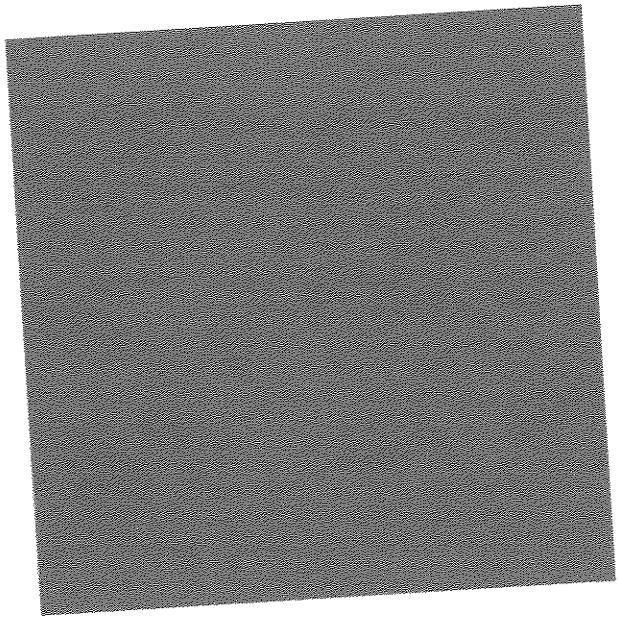

Table 3.16

Summary of Endangered and Potentially Endangered Fauna and Flora of Monroe County (1)

Status Designation (2)	Fish	Amphibians/ Reptiles	Birds	Mammals	Invertebrates	Plants	Total
FGFWFC (3)							
Endangered	0	6	3	6	3	-	18
Threatened	1	6	7	0	0	-	14
Special Concern	2	2	8	0	1	-	13
Subtotal	3	14	18	6	4	-	45
FDA (4)							
Endangered	-	-	-	-	-	41	41
Threatened	-	-	-	-	-	33	33
Commercially Exploited	-	-	-	-	-	5	5
Subtotal	-	-	-	-	-	79	79
USFWS (5)							
Endangered	0	5	3	5	1	3	17
Threatened	0	2	3	0	1	0	6
Threatened (S/A)	0	1	0	0	0	0	1
PE	0	0	0	1	0	0	1
PT	0	0	0	0	0	0	0
C1	0	0	0	0	0	3	3
C2	0	3	4	2	0	11	20
Subtotal	0	11	10	8	2	17	48
CITES (6)							
Appendix I	0	6	2	1	0	0	9
Appendix II	0	1	3	0	0	14	18
Subtotal	0	7	5	1	0	14	27

(1) Excluding mainland areas of Monroe County.
(2) T(S/A) = Threateded Due to Similarity of Appearance
PE = Proposed Endangered
PT = Proposed Threatened
C1 = A candidate for federal listing, with enough substantial information on biological vulnerability and threats to support proposal for listing. See note below.
C2 = A candidate for listing, with some evidence of vulnerability, but for which not enough data exist to support listing. See note below.
SSC = Species of Special Concern
CE = Commercially Exploited
I = Appendix I Species
II = Appendix II Species
(3) Florida Game and Fresh Water Fish Commission (list published in Section 39-27.03-05, Florida Administration Code).
(4) Florida Department of Agriculture and Consumer Services (list published in Preservation of Native Flora of Florida Act, Section 581.185-197, Florida Statutes).
(5) United States Fish and Wildlife Service (list published in List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11-12).
(6) Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Note: Although C1 and C2 species are not protected under the Endangered Species Act, in the Federal Register notice (Volume 55, Number 35, pages 6184-6229) designating them as "candidates," the U.S. Fish and Wildlife Service "...encourages their consideration in environmental planning..."

Sources: Florida DNR, 1990c.
Florida Game and Fresh Water Fish Commission, 1991.
Lazell, 1989.
Monroe County Department of Planning, 1989.
The Nature Conservancy, 1989.
The Nature Conservancy, (no date).

3.13.2 General Recommended Conservation Actions For Protection of Threatened and Endangered Species

A. Mapping and Data Collection for Designated Species

Monroe County's mapped data base and records regarding the occurrences of designated species are incomplete. For species which have received local attention, such as Key deer, the County's data base and reference materials are fairly extensive. For others, there is only a small amount of information compiled. Without this information it is impossible to protect designated species from habitat loss, habitat degradation or population threats.

Monroe County should expand and update its maps and data base of studies on all designated species known to occur in the County. Information should be obtained from FWS, FGFWFC, FDA, DNR, FNAI, The Nature Conservancy, and local scientists. Mapped species occurrence data should be obtained and updated annually from FNAI. These data should be entered into the Geographic Information System (GIS). To the extent possible, occurrence data should be plotted on specific parcels for which occurrences have been recorded, particularly for plants. This will assist in evaluation of wildlife impacts associated with development proposals on specific properties.

As a supplement to mapped occurrence data, the County should identify from best available data, the probable concentrated range of wildlife for designated species. The County should seek a cooperative agreement with FNAI, FGFWFC and FWS to assist with these designations. Probable range data should be entered into the GIS.

B. Coordination with Federal and State Agencies

Coordination with federal and state agencies regarding protection of designated species is relatively limited. State agencies responsible for protection of state-designated species include DNR, FGFWFC, and FDA. The FWS is the primary federal agency responsible for protection of federally-designated species, including preparation of recovery plans. Currently there is no coordination regarding species protection, aside from what is mandated by state rules and federal regulations when development applications for specific types of projects are under review. In addition there is little now, aside from efforts to protect several of the more popular species, such as the Key deer (Odocoileus virginianus clavium) and the Schaus' swallowtail butterfly (Heraclides aristodemus ponceanus), in the way of cooperative efforts to promote species protection.

Monroe County should seek to work cooperatively with FWS, FGFWFC and FDA to promote the recovery of designated wildlife species. The County should routinely notify these agencies when development proposals are received for sites having historic and/or current occurrences of species designated as threatened or endangered. Of primary importance, should be cooperation with these agencies to locate potential introduction sites for designated species, particularly for those which are seriously endangered, such as the Stock Island Tree Snail (Orthalicus reses) and the three federally-designated plant species. Monroe County should assist, to the extent that it is able, with acquisition of reintroduction sites and sites having known populations of designated species. The County Biologist should participate in development of new recovery plans and revisions to old recovery plans for federally-designated species. When state or federal agencies undertake specific recovery

actions in the County, the County should support these activities as appropriate through public education, law enforcement, data collection, etc.

C. Revisions to the Land Development Regulations to Protect Designated Species

Several revisions to the Monroe County Land Development Regulations (LDR's) (Monroe County BOCC, 1990) would better protect designated species from habitat loss, habitat degradation, or population threats.

In general implementation of a requirement for an environmental impact assessment (EIA) for major developments would better confirm the presence of designated species on or in the vicinity of the development parcel. Specifically the EIA should require a species survey to include, at a minimum: designated species known to inhabit the biological communities similar to those existing on the site in the project area; an assessment of the probable impacts on those species associated with the proposed development; and, identification of measures that will mitigate the identified wildlife impacts.

The County currently utilizes a "Habitat Evaluation Index" for purposes of establishing the ecological value of development sites, and in turn, the applicable open space and maximum residential densities. Among several other measures, this index incorporates measures related to the presence and abundance of threatened and endangered plant species and the presence of threatened and endangered animal species. After five years of using the HEI in the review of development applications, the Monroe County Biologist has recommended that revisions be made to the HEI procedure. These are recommended to make the HEI procedure more scientifically defensible and ecologically meaningful. In particular, the present HEI requires siting of a designated animal at the time of analysis rather than relying on documented occurrences. Although it is theoretically possible to locate an animal if it is on a site, seasonal and daily variability in animal activity and the practicality of doing a timely analysis often make this impossible. Consequently, revisions are needed to the HEI in order to more effectively consider the value of upland biological communities as habitat for designated species.

In order to protect habitat of several designated species, existing development regulations should be strengthened to require 100 percent open space in undisturbed salt marsh and buttonwood wetlands. Further, the LDR's should prohibit development on offshore islands which have been documented at least once as a bird rookery or nesting sites.

D. Monitoring Prohibition of FKAA Water Connections to Selected Federally-Designated Habitat Areas

Mandatory FWS requirements prohibit FKAA from providing water connections to areas within Crocodile Lake National Wildlife Refuge, National Key Deer Refuge (areas on Big Pine Key, No Name Key and Big Torch Key), and tropical hardwood hammocks within its jurisdiction (FKAA, 1989). Monroe County should continue to monitor FKAA to confirm compliance with this prohibition.

E. Management Guidelines for Landowners

Many recovery plans for federally-designated species identify the need for public education regarding activities detrimental to habitat and populations of these species. Education is typically needed to inform local residents in critical habitat areas regarding applicable federal and/or state law as well as design and management guidelines for land development and property management.

Monroe County should develop brief information brochures for use by developers and landowners within critical habitat areas which will inform them regarding activities disruptive or harmful to specific wildlife species. A separate set of guidelines should be developed for each species, with initial efforts focused on federally-designated species. As appropriate for each species, the guidelines should address items such as feeding, free-roaming domestic pets, noise, traffic, fencing, pesticide applications, etc. Existing laws and penalties for their violation should be identified. Guidelines should be made available to the general public. Specific management guidelines should be incorporated when appropriate as stipulations for land development orders.

F. Protection from Free-Roaming Domestic Pets

Dog- and cat-related deaths of protected populations are serious threats to the recovery of many designated species. This is typically the most frequent cause of man-induced mortality for some species, particularly small mammals. The problem is exacerbated as residential development increases in close proximity to habitats of designated species. Presently in Monroe County there is inadequate funding to support animal protection efforts at the level required to adequately safeguard these populations throughout the Keys.

In order to address this problem, the Monroe County Biologist should work cooperatively with the Animal Control Department to develop and implement an animal control plan. This plan should identify areas within the County where priority should be placed in enforcing animal control laws so as to protect native wildlife populations, particularly designated species. These priorities should be reviewed periodically. The Animal Control Department should be responsible for addressing the long-term staffing, facility and financial requirements to support implementation of the plan.

G. Protection from Exotic Plant and Animal Species

Escape of non-native plant and animal species into the general environment can have devastating impacts on naturally native plant and animal species. In the extreme, the proliferation of invasive plants such as Australian pine (Schinus terebinthifolius) and Brazilian pepper (Casuarina equisetifolia) is proof of the extent to which non-native plant material can invade and degrade natural biological communities.

Monroe County should adopt strict policies prohibiting planting of invasive exotic plants throughout the County and should continue in its efforts to educate the public of the need to remove invasive plant materials from existing developed areas. Removal of invasive plants from development sites should be required as a condition of a certificate of occupancy for new development.

The Monroe County Biologist should coordinate with FGWFWC and FWS to develop a list of undesirable exotic wildlife populations (exclusive of cats, dogs and horses). The County should then

consider adoption of an exotic wildlife ordinance which shall prohibit and/or restrict the sale and handling of listed undesirable exotic species.

H. Recovery Activities which could be Implemented by Monroe County for Protection of Federally-Designated Threatened and Endangered Species

Many recovery activities could be implemented by Monroe County to prohibit the destruction of federally-designated threatened and endangered species and to protect their habitat.

Sections 3.13.3 through 3.13.23 below generally describe the status, distribution and habitat of the 21 species of federally-designated plants and animal. Also included are a summary of the reasons for decline of these species in the Florida Keys and a list of recovery activities which could be implemented for each species by Monroe County.

I. Recovery Activities which could be Implemented by Monroe County for Protection of State-Designated and Locally Rare Species

In addition to the 21 federally-designated species, the Florida Keys provide habitat to 82 plant and animal species designated by the State as threatened or endangered, 4 commercially exploited plants, and 12 animal species of special concern.

There are many plant and animal species in the Florida Keys which while not designated as threatened or endangered at the state or federal level are considered locally rare. Presently a list of these locally rare species is not available. Lacking this list it is impossible to protect such species from habitat loss, habitat degradation, or population threats. Monroe County should develop lists of locally rare plant and animal species. This should be done in cooperation with FWS, FGFWFC, FDA, DNR, FNAI, The Nature Conservancy, the National Audubon Society Research Department and local scientists.

Measures have not been identified at this time for protection of state-designated and locally rare **animal** species. The Monroe County Biologist should assess priorities for such measures and pursue their development and implementation. State-designated and locally rare **plant** species are addressed below in Section 3.13.2.J.

J. Actions to Protect Designated Plants, Locally Rare Plants, Champion Trees, Specimen Trees and Mature Native Trees

Section 9.5-345 of the Monroe County Land Development Regulations (BOCC, 1990) does not allow disturbances to champion trees, specimen trees or plants listed by the FWS as threatened or endangered. Specimen trees are defined as those having a diameter at breast height (dbh) that is greater than seventy-five (75) percent of the record tree of the same species for the State of Florida.

Current county policy requires that development be sited to minimize impacts on species designated by FDA (see Table 3.15) and native trees with diameter at breast height (dbh) of four (4) inches or greater. Similar protection is needed for species which are designated as locally rare (see Section 3.13.2.I above). When avoidance of these species or mature trees is not possible, then

transplantation is required on-site. When the probability of survival (defined as 100 percent survival after one year) is low, then the applicant must make payment to the County for general restoration purposes or donate nursery stock to county or state restoration projects according to a designated replacement schedule. When replacement stock is not available, then payments must be made in lieu of donations of stock, sufficient to purchase stock in numbers corresponding to the replacement schedule.

3.13.3 Marine Turtles

A. Status, Distribution and Habitat Description

Marine turtle nesting season in the Florida Keys generally lasts from April through October each year. Turtles will use most sandy beach areas. While five species of turtles are found in marine waters off the Keys, the Atlantic Loggerhead is the most common turtle which uses the beaches of the Keys for nesting.

Atlantic Loggerhead (Caretta)
The loggerhead turtle is a marine species found world-wide in temperate and subtropical waters. It nests in the USA on sandy beaches from Florida to North Carolina. The loggerhead is highly migratory. Adult females return to the same beach to renest in several years and tagged animals have been recaptured up to 1,500 miles from the site of trapping (U.S.FWS, 1979b).

The loggerhead is an omnivorous species consuming both plant and animal material. Its primary foods include mollusks, crustaceans, and other marine animals. In the Keys, loggerheads can be expected in all waters and marine habitats.

The loggerhead is the only species of marine turtle which regularly utilizes Florida Keys beaches for nesting and egg laying. In recent years nesting has been documented on Lower Matecumbe Key, Long Key, Coco Plum Beach, Bahia Honda Beach, Big Munson Key, Sawyer Key and Lower Sugarloaf Key.

The U.S. population has been estimated to number 25,000 to 50,000 individuals, of which approximately 15,700 are sexually mature females (Lund, 1978). It is estimated that more than 90 percent of the nesting females in the U.S. utilize nesting beaches in Florida (Lund, 1978).

Atlantic Green Turtle (Chelonia mydas)
The green turtle is a marine species that occurs throughout the Caribbean Sea, the Gulf of Mexico and the South Atlantic waters of the Bahamas and the islands of the West Indies.

The green turtle is highly migratory. Adults of both sexes travel to waters off nesting beaches where mating occurs, and the females then come ashore to lay eggs. The hatchlings then return to the sea and eventually travel to the feeding grounds which may be quite distant from the nesting beaches.

The green turtle is primarily herbivorous, its main food being turtle grass (Thalassiatestudium). The extensive seagrass beds in Monroe County waters represent important feeding habitat for this species (Zieman, 1982).

Green turtles nest regularly on beaches in the Keys (Lazell, 1989).

Leatherback Turtle (Dermochelys coriacea)
The leatherback turtle is the most pelagic of the marine turtle species. It is a worldwide species with nesting beaches in the tropics and sub-tropics, but it is often observed in more northern waters.

The leatherback is a carnivorous species whose primary food is jellyfish. It nests on sandy beaches from April to August when the females lay eggs. After 55 to 74 days the eggs hatch and the young return to the sea (U.S.FWS., 1977). In recent years nests have been observed on beaches from Miami to Flagler County on the Atlantic coast of Florida (Lund, 1978).

Today, leatherbacks are scarce in Keys' waters (Lazell, 1989). There are no records of nestings on beaches of the Florida Keys.

Atlantic Hawksbill Turtle (Eretmochelys imbricata)
The hawksbill turtle is a marine species that occurs in tropical oceans worldwide. It nests on beaches scattered throughout its range, and spends most of its life in coastal waters. The hawksbill is considered omnivorous, feeding on mollusks, crustaceans and marine algae (Lund, 1978).

In Florida, the hawksbill is most often observed near coral reefs (Lund, 1978). There is one documented nesting incident of the hawksbill in the Keys.

Atlantic Ridley Turtle (Lepidochelys kempi)
The ridley turtle is a marine species that primarily inhabits the Gulf of Mexico but is also found in the Caribbean Sea and the Atlantic Ocean. The only known nesting beach is on the Gulf coast of Mexico.

The ridley turtle is omnivorous, feeding on invertebrates, fish and marine plants. In the Florida Keys, it would be found in nearshore waters, mangrove creeks and bays. There are no records of nesting in Florida.

B. Reasons for Decline and Recovery Activities for Marine Turtles

Several factors have contributed to the decline in populations of marine turtles (U.S.FWS, 1984b). Reasons for decline in the Florida Keys are summarized as follows:

Destruction or Modification of Habitat:

* beach nesting site disturbances associated with:
  - invasive plants (impenetrable root structures)
  - artificial lighting (from adjacent development)
  - mechanical beach cleaning
* water quality degradation
  - nearshore water pollution
  - marine litter
  - dredge and fill
* seagrass bed destruction
  - damage from recreational boating

Predation and/or Destruction:

* nesting site predation by:
  - native wildlife populations
  - free-roaming domestic pets
  - human disturbance (egg collecting/nest destruction)
* recreational boating
* incidental catch.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of marine turtles and to protect their habitat include:

* acquisition of undisturbed beach/berm areas regularly used as marine turtle nesting sites
* restoration of publicly-owned beaches
* adoption of a "Turtle Protection Ordinance", applicable to existing and new development, which will:
  - prohibit activities disruptive to marine turtles
  - restrict artificial lighting
  - restrict mechanical beach cleaning
  - protect marine turtles from predation by human activities and free-roaming pets
* adoption of revised land development regulations, applicable to new development, which will:
  - restrict new beachfront lighting
  - require setbacks from turtle nesting sites
  - require restoration of beaches
* general support for conservation efforts of Save A Turtle, Inc.
* preparation of management guidelines for landowners of beachfront residences and properties (see Section 3.13.2.F above) with particular emphasis on problems of nest site disturbance and hatchling disorientation
* adoption of speed controls in nearshore waters and/or creation of a boating restricted or boating protection zone
* support for establishment of an oil response team for the Florida Keys
* coordination with FWS and DNR to determine additional protection measures which could be implemented by Monroe County
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39 F.A.C.)
* implementation of management strategies for water quality protection consistent with the Florida Keys National Marine Sanctuary Water Quality Protection Plan.

3.13.4 American Crocodile (Crocodylus acutus)

A. Status, Distribution and Habitat Description

The American crocodile is found in several areas of tropical coastal swamps throughout the Caribbean basin and the Pacific coast of Central and South America. In the U.S., it occurs from Biscayne Bay on the east coast of Florida to the Ten Thousand Islands on the west coast, although the breeding habitat is much more restricted.

The American crocodile inhabits coastal waters, with a preference for protected bays and sounds, and adjacent mangrove swamps. It utilizes man-made bodies of water such as canals and borrow pits if other conditions are suitable. It requires loose soils above the elevations of tides for its nest sites where the females lay eggs. Natural nesting sites are usually located on beaches or the waterward areas of tropical hardwood hammocks. Deep water access for the adult female close to a potential nest site appears to be a second requirement for nesting (Ogden 1978a). It may utilize dredge spoil for nesting sites, if other conditions are favorable. Nesting activity begins in April when the females re-work nest sites or establish new ones. The females lay 20 to 80 eggs in late April or early May; the young hatch in late July or early August and are dug out by an adult, presumably the female (Ogden, 1978b).

The Florida Keys comprise a critical portion of the American crocodile's range in the U.S. In recent years, crocodiles have nested in two locations in the Keys, one in the Lake Surprise area and the other on the bay side of Upper Key Largo. There are three to six nests per year in the Keys, which represent about 30 percent of all crocodile reproduction in the U.S. (pers. comm., Paul Moler). This rate of nesting activity is probably indicative of an estimated Upper Key Largo population of 120 to 150 animals (pers. com., Paul Moler).

The bay side of Upper Key Largo is good crocodile habitat because there are suitable nesting sites close to extensive areas of undisturbed habitat. In contrast, the mainland side of Barnes Sound and other areas have sufficient feeding habitat but no suitable nesting sites (Ogden, 1978a). Crocodiles are also known to be present in the Lower Keys on Big Pine, Cudjoe, No Name, Big Munson, and Middle Torch Keys (Lazell, 1989). However, there is no evidence of a reproductive population (Jacobsen, 1983; U.S.FWS, 1984a).

Outside of the Keys, other crocodile nesting sites are on the mainland of Florida within Everglades National Park, on mangrove islands in Florida Bay within Everglades National Park, and at Turkey Point in Biscayne Bay.

B. Reasons for Decline and Recovery Activities for the American Crocodile

Several factors have contributed to the decline in populations of the American crocodile (U.S.FWS, 1984a). Reasons for decline in the Florida Keys are summarized as follows:

Destruction or Modification of Habitat:

* historic loss of mangrove habitat
* water quality degradation
  - nearshore water pollution
  - marine litter
  - dredge and fill

Predation and/or Destruction:

* nesting site predation by:
  - native wildlife populations
  - human disturbance (egg collecting/nest destruction)
* hatchling predation by native wildlife populations, particularly raccoons

* highway mortality along the "eighteen mile stretch" segment of US 1 and along Card Sound Road
* commercial and net fishing in Florida Bay
* historic commercial harvesting

Indirect Disturbances:
* human disturbances during courtship and nesting periods.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the American crocodile and to protect its habitat include:

* coordination with FWS and FGFWFC to determine additional protection measures which could be implemented by Monroe County
* public education concerning human disturbances during courtship and nesting periods
* adoption of speed controls in nearshore waters and/or creation of a boating restricted or boating protection zone
* support for establishment of an oil response team for the Florida Keys
* implementation of management strategies for water quality protection consistent with the Florida Keys National Marine Sanctuary Water Quality Protection Plan.

3.13.5 American Alligator (Alligator mississippiensis)

A. Status, Distribution and Habitat Description

The American alligator occurs throughout Florida and the southeastern United States from Texas to North Carolina, and up the Mississippi basin as far as Arkansas and Oklahoma. Alligators are reproductively active in the Florida Keys (Jacobsen 1983). Current population counts for the Keys are not known.

Alligators have been sighted in recent years on Cudjoe Key, Middle Torch Key, Big Pine Key, and Little Pine Key. The primary habitats of alligators are freshwater wetlands and fresh waterbodies. In the Keys, the most extensive freshwater wetlands occur on Big Pine Key, where habitat has actually been enhanced for alligators by the excavation of approximately 100 miles of mosquito-control ditches. These ditches provide connections for alligators to move between freshwater areas, as well as increased food supplies (Jacobsen, 1983). The greatest population occurs on Big Pine Key in the vicinity of the Blue Hole in the National Key Deer Refuge (Weiner, 1979; Jacobsen, 1983; Lazell, 1989). Nests are typically constructed of vegetation piled above the reach of water. Alligators in the Lower Keys have also been observed in marine habitats (Jacobsen, 1983).

B. Reasons for Decline and Recovery Activities for the American Alligator

Several factors have contributed to the decline in populations of the American alligator. Reasons for decline in the Florida Keys are summarized as follows:

Destruction or Modification of Habitat:
* historic loss of freshwater wetland habitat

Predation and/or Destruction:

* nesting site predation by:
  - native wildlife populations
  - human disturbance (egg collecting/nest destruction)
* hatchling predation by native wildlife populations, particularly raccoons
* historic commercial harvesting.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the American alligator and to protect its habitat include:

* support for ongoing land acquisition by FWS, SFWMD and DNR in the Lower Keys involving freshwater wetlands and critical recharge areas of freshwater lenses
* county-acquisition of freshwater wetlands and critical recharge areas of freshwater lenses in the Lower Keys
* continued prohibition of structures and filling in freshwater ponds and wetlands
* mapping of the freshwater lenses of the Lower Keys, including identification of critical recharge areas;
* implementation of special measures to protect the quantity and quality of groundwater recharge to the freshwater lenses
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39, F.A.C.)
* coordination with FWS and FGFWFC to determine additional protection measures which could be implemented by Monroe County.

3.13.6 Eastern Indigo Snake (Drymachron corais couperi)

A. Status, Distribution and Habitat Description

The Eastern indigo snake is found throughout Florida and southeast Georgia. Disjunct populations may be present in South Carolina, Alabama and Mississippi (U.S.FWS., 1982a). In the Keys, records indicate that the species occurs throughout Upper Key Largo (north of US 1/C-905 intersection), from No Name Key to Sugarloaf Key, on Big Torch Key, Middle Torch Key, Big Pine Key and Plantation Key.

The indigo snake is carnivorous, preying upon small mammals, birds, lizards, frogs and other snakes, including venomous species (Kochman, 1978).

In the Keys and south Florida the indigo snake utilizes a number of habitats including tropical hardwood hammocks, slash pinelands, beach/berm systems, freshwater wetlands, tidal mangroves, transitional habitats and disturbed lands recolonized by non-native vegetation (Kochman, 1978; Steiner et al, 1983). It appears to prefer the more upland habitats, but it also has been observed swimming in both fresh and saltwater (Steiner et al, 1983).

Neither the range requirements per individual indigo snake in the Keys nor the range overlap have been studied. However, the large areas utilized by each animal in other areas and the fact that it is a large carnivore would argue that the density per unit area of habitat is quite low. In Georgia,

Speake, et al (1979, cited in Steiner et al., 1983) found that average ranges varied seasonally between 241 acres (summer) and 12 acres (winter).

B. Reasons for Decline and Recovery Activities for the Eastern Indigo Snake

Several factors have contributed to the decline in populations of the eastern indigo snake (U.S.FWS, 1982a). Reasons for decline in the Florida Keys are summarized as follows (Lazell, 1989):

Destruction or Modification of Habitat:

* loss of habitat to development
* degradation of habitat due to human disturbance and interference with natural burn cycles and natural succession

Predation and/or Destruction:

* commercial exploitation for the pet trade
* highway mortality
* deliberate human persecution.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the eastern indigo snake and to protect its habitat include:

* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality upland vegetation communities and habitat of threatened and endangered species
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39, F.A.C.)
* public education regarding the non-venomous nature of the eastern indigo snake
* monitoring of FKAA restrictions of water supply hook-ups in eastern indigo snake habitat
* coordination with FWS and FGFWFC to determine additional protection measures which could be implemented by Monroe County.

3.13.7 Southern Bald Eagle (Haliaeetus leucocephalus)

A. Status, Distribution and Habitat Description

The southern bald eagle is a riparian species normally associated with coastlines, rivers, lakes or extensive marshes. The original Florida population probably exceed 1,000 breeding pairs and has declined to a state-wide population of 300 to 325 breeding pairs (Robertson, 1978b).

Nesting and breeding activities occur year round. Eagles often nest in tall trees such as pines. In the Keys they will also nest in mangroves, particularly on overwash mangrove islands. Eggs are normally laid in winter.

In the Upper Keys, there are approximately 35 nesting pairs utilizing mangrove islands in the Florida Bay portion of Everglades National Park north and west of Key Largo, Plantation Key, Windley Key and Islamorada (Robertson, 1978b). These birds are often observed over these islands and adjacent

oceanic and bay waters. In the Lower Keys there two to four nesting pairs between the Seven Mile Bridge and the Marquesas (Robertson, 1978b). These birds have been observed over the Keys and waters of the region. Exact nest locations are known but have not been mapped to discourage disturbances.

B. Reasons for Decline and Recovery Activities for the Southern Bald Eagle

Several factors have contributed to the decline in populations of the southern bald eagle (U.S.FWS, 1989d). Reasons for decline in the Florida Keys are summarized as follows:

Destruction or Modification of Habitat:
* loss of habitat to development

Predation and/or Destruction:
* deliberate human persecution (shooting)
* environmental contamination (factor contributing to decline nationally in general)

Indirect Disturbances:
* human disturbances, particularly during nesting periods.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the southern bald eagle and to protect its habitat include:

* identification of historic nesting sites in the Upper and Lower Keys
* acquisition of parcels having historic nesting sites
* prohibition of development on offshore islands used as nesting sites
* direction of growth away from active nesting sites
* preparation of management guidelines for landowners whose properties contain or are in close proximity to nesting sites (see Section 3.13.2.F above)
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality upland vegetation communities and habitat of threatened and endangered species
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39, F.A.C.)
* coordination with FWS and FGFWFC to determine additional protection measures which could be implemented by Monroe County.

More specifically, the Permit Allocation and Point System of the Comprehensive Plan should consider assignment of a negative point rating to developments proposed within a certain horizontal distance of nest sites. This distance should be established by the Monroe County Biologist in cooperation with FWS, FGFWFC, and the National Audubon Society Research Department.

3.13.8 Wood Stork (Mycteria americana)

A. Status, Distribution and Habitat Description

The wood stork is a tropical and sub-tropical wading bird that occurs in Mexico, Central America, South America and the southern United States. Historically there were breeding colonies from Texas to South Carolina, but the range has shrunk to Florida and southeastern Georgia (Ogden, 1978c).

The wood stork inhabits freshwater and brackish coastal wetlands. It nests in cypress or mangrove trees. Nesting colonies form in November through January, and the offspring fledge before seasonal rains begin in June (Ogden, 1978c). There are several large rookeries in Everglades National Park, including Madeira Rookery (Ogden et al., 1978), which is approximately 15 miles from the nearest point on Key Largo.

The wood stork feeds on small fish captured in shallow water (6 to 10 inches deep) by a specialized behavior known as tacto-location (Ogden, 1978c). The wood stork is dependent, to a much greater degree than other wading birds, on a highly concentrated supply of fish for food, especially during the November-May nesting period (Kushlan, et al., 1975). The main food species include sailfish mollies (Poecillia latipinna), marsh killifish (Cypridon veriegatus) all of which are common species in the mangrove swamps of the mainland and the Keys (Ogden, et al., 1978).

The wood stork is only an occasional visitor to the Florida Keys. Its primary habitat is on the Florida mainland. There are no nesting colonies in the Keys. The mangrove areas of Key Largo are utilized as feeding habitat only rarely by wood storks, who appear to favor mainland areas. However, wood storks have been observed to fly 80 miles from their nests to feeding grounds (Ogden et al., 1978), making it possible for them to utilize mangrove areas on Key Largo. Therefore, loss of Key Largo mangrove areas could cause a loss of wood stork feeding habitat within range of a known nesting site.

The wood stork populations have declined drastically in Florida. the population in 1975 was estimated to be 12,000 birds, a 600 percent decrease from the 1930's estimated population of 75,000 (Ogden, 1978c). The breeding population in Everglades National Park suffered a threefold decline in numbers form 1960 when 6,000 were present, to 1975 when 2,300 were present (Ogden, 1978c).

The wood stork is an occasional rare visitor to the Florida Keys, found primarily in the Everglades National Park (Robert Pace, U.S. FWS, personal communication, 1991).

B. Reasons for Decline and Recovery Activities for the Wood Stork

The generally accepted explanation for the decline of the wood stork is the reduction in the food base attributed to the loss of wetland habitat and changes in hydroperiod in the interior wetlands of south Florida (U.S.FWS, 1986b).

No management actions are identified as possible county recovery action for the wood stork as the population does not typically range into the Florida Keys.

3.13.9 Bachman's Warbler (Vermivora bachmanii)

A. Status, Distribution and Habitat Description

The Bachman's warbler is the rarest of all American warblers, and is considered to possibly be extinct (Lazell, 1989). Historically these warblers nested in the interior United States from Missouri to Virginia and migrated, passing through the Florida Keys, to their wintering habitat in Cuba. Specimens have not been documented in the Keys since 1942 (Lazell, 1989). If any Bachman's warblers remain, they would be found in the mangroves and hardwood hammocks, primarily in the Lower Keys, during from July through September (Lazell, 1989).

B. Reasons for Decline and Recovery Activities for the Bachman's Warbler

Shooting has been the suggested cause of the decline of the Bachman's warbler (Lazell, 1989). The FWS has not prepared a recovery plan for the Bachman's warbler. Monroe County has not identified any recovery actions. In the unlikely event that any Bachman's warblers survive, existing Monroe County regulations prohibiting development in mangroves and current acquisition programs for hardwood hammocks would serve to protect habitat in the Keys used by this species during its early spring and late summer migration.

3.13.10 Piping Plover (Charadrius melodus)

A. Status, Distribution and Habitat Description

The piping plover is a small Nearctic shorebird. There are three populations in the United States, including those on the east coast of North America, in the Great Lakes region, and in the Northern Great Plains. The east coast population breeds on sandy beaches from Newfoundland south to South Carolina.

Most piping plovers which breed on the Atlantic Coast winter from North Carolina to Key West. In the Florida Keys the stretch from the Seven-Mile Bridge to Bahia Honda is utilized as wintering grounds (U.S.FWS, 1988a). A major wintering ground is the wetlands system on Ohio Key.

Available data suggest that the entire Atlantic Coast population has been decreasing since 1955 or earlier (U.S.FWS, 1988a).

B. Reasons for Decline and Recovery Activities for the Piping Plover

Several factors have contributed to the decline in populations of the piping plover (U.S.FWS, 1988a). Specific studies of wintering grounds in the Keys have not been undertaken. Nevertheless, it has been suggested that the factors affecting the population in its wintering grounds are as follows (U.S.FWS, 1988a):

Destruction or Modification of Habitat:

* loss of habitat to development, shoreline stabilization structures and dredging

Predation and/or Destruction:

(none identified for wintering grounds in the Keys)

Indirect Disturbances:
(none identified for wintering grounds in the Keys).

Piping plovers in the Florida Keys congregate on wintering grounds on Ohio Key. Monroe County has designated this wintering ground as an Area of Critical County Concern (ACC), explicitly for purposes of protecting the piping plover habitat (see Land Use Section 2.1.5 D). Section 9.5-478 of the Land Development Regulations (Monroe County BOCC, 1990) explicitly limits future uses on Ohio Key to 20 recreational vehicle parking spaces or campsites. These regulations should remain in place as long as the site remains in private ownership. When application is made in the future for building permits to construct the permitted RV/campsites, the application should be subject to the Permit Allocation System and Point System of the Comprehensive Plan. The Permit Allocation and Point System should consider assigning a negative point rating to developments which may adversely affect the piping plover on its wintering grounds. The nature of these impacts should be determined by the Monroe County Biologist in cooperation with the FWS, FGFWFC, and the National Audubon Society Research Department.

3.13.11 Peregrine Falcon (Falco peregrinus tundrius)

A. Status, Distribution and Habitat Description

Historically, the peregrine falcon nested at over 200 sites in the eastern United States and had a worldwide distribution (U.S.FWS, 1979a). Nesting has never been reported in Florida. The peregrines in the state are migratory individuals utilizing the region as wintering habitat. These same birds nest in the Arctic tundra regions (Snyder, 1978).

In the Keys, peregrine falcons can be observed perching on tall trees or hunting in practically any terrestrial, wetland or marine habitat. They are particularly drawn to areas with large concentrations of their prey species, such as overwash mangrove islands supporting nesting colonies and tidal flats where shorebirds and wading birds concentrate. One such area is the southern portion of Ohio Key.

There are no estimates of the winter population numbers for peregrine falcons in the Keys. Snyder (1978) stated that peregrines are relatively non-mobile on their wintering grounds, staying within ranges of a few square miles.

B. Reasons for Decline and Recovery Activities for the Peregrine Falcon

Several factors have contributed to the decline in populations of the peregrine falcon (U.S.FWS, 1979a). Reasons for decline in the Florida Keys are summarized as follows:

Destruction or Modification of Habitat:
* loss of habitat to development

Predation and/or Destruction:
* deliberate human persecution (shooting)

Indirect Disturbances:

* human disturbances.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the peregrine falcon and to protect its habitat include:

* identification of frequented wintering grounds in the Keys
* acquisition of parcels found to be significant wintering sites
* direction of growth away from wintering grounds
* preparation of management guidelines for landowners whose properties contain or are in close proximity to significant wintering grounds (see Section 3.13.2.F above)
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality upland vegetation communities and habitat of threatened and endangered species
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39, F.A.C.)
* coordination with FWS and FGFWFC to determine additional protection measures which could be implemented by Monroe County.

More specifically, the Permit Allocation and Point System of the Comprehensive Plan should consider assigning a negative point rating to developments which may adversely affect the peregrine falcon on its wintering grounds. The nature of these impacts should be determined by the Monroe County Biologist in cooperation with the FWS, FGFWFC, and the National Audubon Society Research Department.

3.13.12 Roseate Tern (Sterna dougallii)

A. Status, Distribution and Habitat Description

The roseate tern is a nearshore bird that occurs on both sides of the Atlantic. Other subspecies occur in the tropical Indian Ocean and western Pacific. Along the Atlantic coast of North America nesting occurs from Nova Scotia to Virginia, in the Florida Keys and in the West Indies (Robertson, 1978a).

The roseate tern is piscivorous, plunge-diving for small fish up to four inches in length in nearshore waters (Robertson, 1978a). Nesting occurs on the bare sand of beaches or on bare fill deposited by man. Nesting usually begins in late May or early June. Keys' nests usually contain two eggs. The incubation period is 21 days. Fledging occurs about one month after hatching and the young may be fed by adults for several more months (Robertson, 1978a). The birds at the largest nesting colony in the Keys and the Dry Tortugas leave by early September (Robertson, 1978a).

Over the past two decades roseate terns have been reported to nest at various locations in the Keys, including the Dry Tortugas, Coco Plum Beach, islands off the Seven Mile Bridge, spoil islands in Key West Harbor, and the Molasses Reef Dry Rocks (Roberston, 1978a). These nesting sites have not been mapped due to the lack of recent confirmation and the apparently sporadic utilization of these sites (exclusive of the Dry Tortugas) by roseate terns.

The population of roseate terns in Florida is estimated to be 250 to 300 breeding pairs, all of which occur in the Keys. Nesting success is generally poor (Robertson, 1978a). Nest sites include rooftops and bridges in the Lower Keys and sandy islands in the vicinity of Boca Chica (Robert Pace, U.S.FWS, personal communication, 1991).

B. Reasons for Decline and Recovery Activities for the Roseate Tern

The U.S. FWS has not completed nor scheduled completion of a recovery plan for the southeastern population of the Roseate Tern (Linda Finger, U.S.FWS, personal communication, 1991).

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the roseate tern and to protect its habitat include:

* identification of historic nesting sites in the Upper and Lower Keys
* acquisition of parcels having historic nesting sites
* prohibition of development on offshore islands used as nesting sites
* direction of growth away from active nesting sites
* preparation of management guidelines for landowners whose properties contain or are in close proximity to nesting sites (see Section 3.13.2.F above)
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality upland vegetation communities and habitat of threatened and endangered species
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39, F.A.C.)
* coordination with FWS and FGFWFC to determine additional protection measures which could be implemented by Monroe County.

More specifically, the Permit Allocation and Point System of the Comprehensive Plan should consider assignment of a negative point rating to developments proposed within a certain horizontal distance of nest sites. This distance should be established by the Monroe County Biologist in cooperation with FWS FGFWFC, and the National Audubon Society Research Department.

3.13.13 Key Largo Wood Rat (Neofoma floridana smallii)

A. Status, Distribution and Habitat Description

The Key Largo wood rat is an endemic subspecies that exclusively inhabits tropical hardwood hammocks and does not utilize any other vegetation community. The nearest mainland relative is north of Lake Okeechobee (Lazell, 1989).

The range of the wood rat formerly extended to southern Key Largo (Schwartz 1952 as cited in Barbour and Humphrey, 1982). At present, the natural range of the wood rat is limited to hammocks in Upper Key Largo (Barbour and Humphrey, 1982). It is also found on Lignumvitae Key, where it was introduced in 1970.

Wood rats usually utilize only hammocks that are sufficiently mature to have a well-defined canopy. The density of nests and animals is positively correlated with the maturity of the hammock (Barbour and Humphrey, 1982).

In 1982 the total population of wood rats in Upper Key Largo was estimated at 654 individuals (Barbour and Humphrey, 1982).

B. Reasons for Decline and Recovery Activities for the Key Largo Wood Rat

The U.S. FWS is currently preparing a recovery plan for the Key Largo wood rat (Linda Finger, U.S.FWS, personal communication, 1991).

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Key Largo wood rat to protect its habitat include:

* direction of growth away from hammocks known to be habitat for the Key Largo wood rat
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality upland vegetation communities and habitat of threatened and endangered species
* monitoring of FKAA restrictions of water supply hook-ups in Key Largo wood rat habitat
* coordination with the FWS during preparation of the Key Largo Wood Rat Recovery Plan to determine additional protection measures which could be implemented by Monroe County.

More specifically, the Permit Allocation and Point System of the Comprehensive Plan should consider assignment of a negative point rating to developments proposed within hammocks documented as habitat of the Key Largo Wood Rat. These areas shall be identified by the Monroe County Biologist in cooperation with FWS and FGFWFC.

3.13.14 Key Deer (Odocoileus virginianus clavium)

A. Status, Distribution and Habitat Description

The Key deer is a distinct geographical race of Virginia white-tailed deer that is endemic to the Lower Keys. Historically, the Key deer ranged from Key West to Duck Key (Barbour and Allen, 1982, as cited in U.S.FWS, 1980). At present, the population is centered on Big Pine Key and No Name Key with the range extending to Big Torch, Middle Torch, Cudjoe, Howe, Annette, Little Pine Island, Sugarloaf, and Knockemdown Keys.

The Key deer utilizes almost all habitats and vegetation communities within its range. It feeds primarily in slash pinelands, mangroves, and transitional habitats. It obtains water from freshwater wetlands and solution holes. It drops fawns in tropical hardwood hammocks. Silvy (1975) found that the deer preferentially utilize slash pinelands and tropical hardwood hammocks compared to other available habitat types. The deer will also feed and travel through open disturbed and moderately developed areas.

Because Key deer are highly mobile animals, estimated range requirements per animal should be used cautiously. Silvy (1975) found that the largest two-year range covered by an adult animal was 1,366 acres, while the smallest two-year range was 227 acres. In Silvy's (1975) study the mean two-year range covered by adult males was 790 acres, while the mean area covered by adult females was 429 acres. By using his population estimate for Big Pine Key and the total acreage of that island, Silvy (1975) estimated that there was one deer per 30 acres.

The geographic distribution of the Key deer is closely tied to the availability and suitability of habitat. At present, approximately two-thirds of the population is concentrated in the Big Pine/No Name area. The remaining one-third of the population, which is also reproductively active, lives outside the area of concentration. Two habitat requirements account for this distribution. First, Key deer require a year-round supply of fresh drinking water, which is a critical factor in their distribution (Jacobson, 1974 as cited in U.S.FWS, 1980). Big Pine Key and No Name Key have relatively abundant freshwater wetlands and solution holes that are fresh year-round. Second, Key deer show a marked preference to feed in freshly burned slash pinelands, where there are abundant foodstuffs at a level they can reach (U.S.FWS, 1980). Big Pine Key and No Name Key again provide the greatest acreage of slash pineland habitat. Key Deer swim between islands, and there is evidence that the Big Pine/No Name Key population migrates to various smaller, outlying islands to feed during the wet season when rainwater has collected, returning to the large islands during the dry season.

The population trends of the Key deer reflect their vulnerability to human impacts. The natural reproductive rate of Key deer is low (U.S.FWS, 1980), meaning that any population recovery following a decline would be slow. The population was reduced to and estimated 25 animals in the early 1950's, primarily by hunting. Protection from this and other threats allowed the population to increase to an estimated 350 to 400 animals in the mid-1970's (U.S.FWS, 1980). However, the population trend of the last decade has apparently been one of gradual decline, such that the total current estimated population throughout its range in the Lower Keys is approximately 250 to 300 animals.

Carrying capacity for the Key deer population on Big Pine Key, defined as the maximum number of deer which can live and adequately reproduce to ensure perpetuity on a prescribed area of land, is estimated to be approximately 200 to 250 deer (Garrett and Robertson, 1989). Assuming approximately 6,000 acres of deer habitat on Big Pine Key, this equates to one deer per 30 acres of deer habitat (Garrett and Robertson, 1989).

B. Reasons for Decline and Recovery Activities for the Key Deer

Several factors have contributed to the decline in populations of the Key deer (U.S.FWS, 1985). These include the following:

Destruction or Modification of Habitat:

* loss and restriction of habitat caused by development, primarily on Big Pine Key
* installation of fencing on private property

Predation and/or Destruction:

* highway mortality (particularly along U.S.1 and Key Deer Boulevard)
* free-roaming domestic pets
* poaching
* accidental drowning of fawns in mosquito control ditches

Activities Altering Distribution and Behavior:
* hand feeding resulting in loss of fear for man and vehicles

Potential Modification of Habitat:
* reduction in availability and/or contamination of freshwater resources.

The FWS (U.S.FWS,1985) has identified three primary objectives for recovery of the Key deer:

(a) to prevent extinction or irreversible decline of the species in the foreseeable future;

(b) to prevent significant negative impacts short of extinction; and

(c) to provide for full recovery of the species.

Both the "Key Deer Recovery Plan" (U.S.FWS, 1985) and the "National Key Deer Refuge Land Protection Plan" (U.S.FWS, 1991a) identify land acquisition as the single most important management strategy that would significantly contribute to the successful maintenance of the Key deer in its natural environment. Presently, there are three acquisition programs ongoing on Big Pine Key which will protect Key deer habitat and provide for freedom of movement and access to most areas of Big Pine Key. These include:

Key Deer Movement Corridors:
600 acres being acquired by FWS including developed and undeveloped tracts which form two separate and distinct north-south corridors connecting lands of the National Key Deer Refuge located north of Watson Boulevard with the lands being acquired at Coupon Bight (see below) located south of US 1

Coupon Bight/Key Deer CARL Project:
1,060 acres being acquired using Preservation 2,000 funds by DNR including most privately-owned lands on Big Pine Key south of US 1 and smaller keys in Coupon Bight, exclusive of Long Beach

Big Pine Key Save Our Rivers Project:
SFWMD has acquired 190 acres using Save Our Rivers Program funds. These include some IS lots located north of US 1 on Big Pine Key. Land acquired through this program will be transferred to FWS as an addition to the National Key Deer Refuge.

Presently there are 2,937 vacant buildable lots on Big Pine Key, most of which lie outside of the above-listed acquisition areas. Conservation activities which could be implemented to reduce the number of these lots which are developed in the future include the following:

* acquisition of vacant IS lots on Big Pine Key by Monroe County

* direction of growth away from habitat areas on Big Pine Key through the Permit Allocation and Point System
* reduction of densities on Big Pine Key by encouraging development proposals which include aggregation of IS lots with permanent restrictions on further future development.

More specifically, the Permit Allocation and Point System should consider assignment of a negative point rating to developments proposed within habitat needed for the successful maintenance of the Key deer in its natural environment. These include proposed developments within the following areas:

* lands within the existing National Key Deer Refuge present acquisition area (U.S.FWS, 1991 b)
* lands within movement corridors (Priority I, II and III Lands) identified by FWS (U.S.FWS, 1991b)
* lands within Coupon Bight CARL project acquisition area.

Roadkill has been the greatest single cause of Key deer mortality, representing an average of 45 per year (U.S.FWS, 1985). This is considered equal to most, if not all, of the yearly production of fawns in a herd of 250 to 300 (U.S.FWS, 1985). Several actions are proposed to reduce highway mortality:

* reduced speed limits on US 1
* measures to ensure greater visibility of Key deer and to decrease Key deer feeding on shoulders in high highway morality areas, such as along Key Deer Boulevard, Watson Boulevard and Wilder Road.

Other recovery activities which could be implemented by Monroe County to prohibit the destruction of Key deer and to protect its habitat include:

* limitations on fencing of private property to achieve a balance between the protection of children, landscaping, domestic animals, and security with the needs of the Key deer
* improvements to roadway shoulders to improve visibility of Key deer and to discourage Key deer grazing on road shoulders
* stepped-up enforcement of existing regulations pertaining to feeding Key deer
* stepped-up enforcement of existing lease laws
* stepped-up enforcement of roadway speed limits
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39, F.A.C.)
* discouragement of tour groups on Big Pine Key
* preparation of management guidelines for landowners in Key deer habitat (see Section 3.13.2.F above) with particular emphasis on problems of fencing, feeding, free-roaming pets, and roadkills
* encouragement of landowners to voluntarily remove Brazilian pepper and Australian pine trees from private property through volunteer programs and by use of incentives
* continued prohibition of structures and filling in freshwater ponds and wetlands
* mapping of the freshwater lenses of the Lower Keys, including identification of critical recharge areas;

- implementation of special measures to protect the quantity and quality of groundwater recharge to the freshwater lenses
- monitoring of FKAA restrictions of water supply hook-ups in Key deer habitat
- coordination with FWS and FGFWFC to determine additional protection measures which could be implemented by Monroe County.

3.13.15 Silver Rice Rat (Oryzomys argentatus)

A. Status, Distribution and Habitat Description

The silver rice rat is an endemic species of the Lower Keys discovered in the 1970's (Spitzer and Lazell, 1978). Nine populations are documented, including those on Cudjoe, Summerland, Big Torch, Middle Torch, Saddlebunch, Little Pine, Raccoon, Water, and Johnson Keys.

The silver rice rat is a wetland-dependent species. It was first discovered in a freshwater marsh on Cudjoe Key. The other eight known populations are all in saltwater wetlands that include mangrove, and saltmarsh and buttonwood wetlands. It has never been found in areas of exclusive mangroves (Spitzer, 1983). The rice rat feeds in all these zones and nests in the saltmarsh and buttonwood zones in tussocks of Sporobolus/Distichilis (Spitzer, 1983). It may obtain freshwater by entering crab holes in the highest buttonwood zone which penetrate the underlying fresh/brackish water lens (Spitzer, 1983). Thus, most of the known populations are dependent upon wetland habitat containing the typical gradient from intertidal red mangrove to the saltmarsh and buttonwood wetlands.

The silver rice rat utilizes a home range that is huge compared to that of other rodents (Spitzer, 1983). The home range of one individual has been documented at 22.8 hectares (56.3 acres), with nest sites up to 1 km (3,281 feet) apart. Because there have been no studies of home range overlap it is not possible to estimate the density of animals in a given habitat area other than to estimate that they are probably very low.

There have been no estimates of the population number, status or current trends of the silver rice rat.

B. Reasons for Decline and Recovery Activities for the Silver Rice Rat

The U.S. FWS currently plans to complete a recovery plan for the silver rice rat in the nest two years (Linda Finger, U.S. FWS, personal communication, 1991).

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the silver rice rat and to protect its habitat include:

- identification of freshwater and salt marsh and buttonwood wetland habitats used by the silver rice rat on Cudjoe, Summerland, Big Torch, Middle Torch, Saddlebunch, Little Pine, Raccoon, Water, and Johnson Keys
- acquisition of identified habitat areas by the County or support for acquisition of these sites by state and/or non-profit conservation organizations
- continued prohibition of structures and filling in freshwater ponds and wetlands

* adoption of revisions to the Land Development Regulations requiring one-hundred (100) percent open space in undisturbed salt marsh and buttonwood wetlands
* coordination with FWS and FGFWFC during preparation of the Silver Rice Rat Recovery Plan to determine additional protection measures which could be implemented by Monroe County.

3.13.16 Key Largo Cotton Mouse (Peromyscus gossypinus allapaticola)

A. Status, Distribution and Habitat Description

The Key Largo cotton mouse is an endemic subspecies of Key Largo. Historically, it occurred throughout Key Largo. Today it is restricted to the northern portion of the island (Brown, 1978; Barbour and Humphrey, 1982). A few cotton mice were introduced onto Lignumvitae Key in 1970, but there have been no studies to determine if the animal is still present (Brown, 1978).

The Key Largo cotton mouse inhabits only tropical hardwood hammocks, to the exclusion of all other vegetation communities and is dependent upon mature tropical hardwood hammocks (Brown 1978; Barbour and Humphrey, 1982).

The range of the cotton mouse on Key Largo is not completely known due to its nocturnal habits, small size and lack of conspicuous nests.

There have been no attempts to make population estimates for the cotton mouse, nor have there been any estimates of population trends.

B. Reasons for Decline and Recovery Activities for the Key Largo Cotton Mouse

The U.S. FWS is currently preparing a recovery plan for the Key Largo cotton mouse (Linda Finger, U.S.FWS, personal communication, 1991).

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Key Largo cotton mouse and to protect its habitat include:

* direction of growth away from hammocks known to be habitat for the Key Largo cotton mouse
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality upland vegetation communities and habitat of threatened and endangered species
* monitoring of FKAA restrictions of water supply hook-ups in Key Largo cotton mouse habitat
* coordination with the FWS during preparation of the Key Largo Wood Rat Recovery Plan to determine additional protection measures which could be implemented by Monroe County.

More specifically, the Permit Allocation and Point System of the Comprehensive Plan should consider assignment of a negative point rating to developments proposed within hammocks

documented as habitat of the Key Largo cotton mouse. These areas shall be identified by the Monroe County Biologist in cooperation with FWS and FGFWFC.

3.13.17 Lower Keys Marsh Rabbit (Sylvilagus palustris hefneri)

A. Status, Distribution and Habitat Description

Jackson (1989) has described the general status distribution and habitat of the Lower Keys marsh rabbit as follows:

> "In recent times, the Lower Keys rabbit was found on at least ten of the Lower Keys, but may now be extirpated from five of these; it does not occur east of the Seven-Mile Bridge. Known localities are on federal (National Key Deer Refuge, Key West Naval Air Station), state (Florida DOT), and private lands. Only six of the 13 remaining known sites are secure from development. Lazell believed that the Lower Keys rabbit was locally common as recently as the 1950's. However, Howe (1988) estimated that only 200 to 400 rabbits remain in small, scattered populations on Sugarloaf, Welles, Annette, Boca Chica, Big Pine and Hopkins Keys.

The Lower Keys rabbit is restricted to marshes, ranging from saline to freshwater. It is believed to be restricted to keys with available freshwater...Marshes are very limited in the Lower Keys, since mangroves occupy many coastal areas, and interior freshwater habitat is scarce. The primary cause of the decline of this rabbit is the filling of wetlands for residential, commercial, and military purposes (Lazell, 1984; Howe, 1988; U.S.FWS, 1989a)."

B. Reasons for Decline and Recovery Activities for the Lower Keys Marsh Rabbit

The U.S. FWS is currently preparing a recovery plan for the Lower Keys marsh rabbit (Linda Finger, U.S.FWS, personal communication, 1991).

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Lower Keys marsh rabbit and to protect its habitat include:

* identification of freshwater and salt marsh and buttonwood wetland habitats used by the Lower Keys marsh rabbit on Sugarloaf, Welles, Annette, Boca Chica, Big Pine and Hopkins Keys
* acquisition of identified habitat areas by the County or support for acquisition of these sites by state and/or non-profit conservation organizations
* continued prohibition of structures and filling in freshwater ponds and wetlands
* adoption of revisions to the Land Development Regulations requiring one-hundred (100) percent open space in undisturbed salt marsh and buttonwood wetlands
* coordination with the FWS during preparation of the Lower Keys Marsh Rabbit Recovery Plan to determine additional protection measures which could be implemented by Monroe County.

3.13.18 Florida Manatee (Trichechus manatus latirostris)

A. Status, Distribution and Habitat Description

The manatee inhabits coastal and riverine waters. It is found in Florida and occasionally in Georgia and along the Caribbean coasts of Central and South America.

The manatee is herbivorous. In the Keys its primary food sources are seagrasses (Thalassia testudinum, Syringodium filiforme, and Halodule wrightii).

Manatees live along both coasts of Florida, along the St. Johns and other rivers, and occasionally in Lake Okeechobee and the waterways leading to it from the Gulf and Atlantic (Hartman, 1978). Populations are concentrated in the warmer waters of south Florida during the winter months of October to April (Hartman, 1978). Twenty-five warmwater refuges have been identified throughout Florida where manatee populations concentrate (Hartman, 1978). None are in the Florida Keys. Manatees are occasionally found as far south as Key West.

The historic level of manatee populations in Florida is thought to have been several thousand. This was reduced by hunting for meat, leather and oil (Hartman, 1978). In 1985 the population was estimated at approximately 1,200 individuals (U.S.FWS, 1989b).

B. Reasons for Decline and Recovery Activities for the Florida Manatee

Several factors have contributed to the decline in populations of the Florida manatee (U.S.FWS, 1989b). Reasons for decline in the Florida Keys are summarized as follows:

Destruction or Modification of Habitat:

* water quality degradation
  - nearshore water pollution
  - dredge and fill
* seagrass bed destruction
  - damage from recreational boating

Predation and/or Destruction:

* boat collisions
* entanglement in fishing gear
* poaching and vandalism
* death of dependent calves due to unknown causes

Activities Altering Distribution and Behavior:

* human harassment by divers, boaters, swimmers, fishermen and snorkelers.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Florida manatee and to protect its habitat include:

* consider adoption of speed controls in nearshore waters and/or creation of a boating restricted or boating protection zone

* request establishment of an oil response team for the Florida Keys
* coordination with FWS and DNR to determine additional protection measures which could be implemented by Monroe County
* enforcement of existing state regulations prohibiting the molesting or harming of endangered species (Chapter 39 F.A.C.)
* implement management strategies for water quality protection consistent with the Florida Keys National Marine Sanctuary Water Quality Protection Plan.

3.13.19 Schaus' Swallowtail Butterfly (Heraclides aristodemus ponceanus)

A. Status, Distribution and Habitat Description

The Schaus' swallowtail butterfly is endemic to southeastern Florida and the Florida Keys. Historically, the Schaus' swallowtail was collected from mainland areas around what is now Miami to Lower Matecumbe Key. Its present range is believed to be restricted to Upper Key Largo, Elliott Key, Adams Key, Totten Key, Old Rhodes Key, Swan Key and Upper Matecumbe Key (Emmel, 1986).

Tropical hardwood hammocks are the exclusive habitat of the Schaus' swallowtail butterfly. The eggs are laid almost exclusively on the host plant torchwood (Amyris elemifera), although oviposition has been observed on wild lime (Zanthoxylum fagara) (Baggett, 1982; Loftus and Kushlan, 1982). Tropical hardwood hammocks and torchwood are found in the Lower Keys and other areas where the Schaus' swallowtail is absent. Therefore, there may be other, more subtle, habitat requirements acting on the species that are not presently known (U.S.FWS, 1982b).

The adult butterflies usually emerge between late April and early June for the flight period that lasts about three weeks (Baggett, 1982). The rarity and short flight period of the Schaus' swallowtail mean that comprehensive surveys or potential habitat are logistically impractical. As a result population estimates remain uncertain. However, it is clear that the range of the species has shrunk, within historic periods, from its previous coverage to Upper Key Largo and various keys within Biscayne National Park. The actual numbers have always been very low, with year to year fluctuations (U.S.FWS, 1982b). From 1973 to 1984, the Schaus' swallowtail was in dramatic decline, with individuals located on three keys in Biscayne National Park and one individual on north Key Largo (Emmel, 1986). In 1985 the population began to reestablish itself. In 1986, the Elliott Key population was between 750 and 1,000 adults, with small populations of 50 to 80 adults and immatures on each of Old Rhodes, Totten, and Adams Keys (Emmel, 1986).

B. Reasons for Decline and Recovery Activities for the Schaus' Swallowtail Butterfly

Several factors have contributed to the decline in populations of the Schaus' swallowtail butterfly (U.S.FWS, 1982b). Reasons for decline in the Florida Keys are summarized as follows:

Destruction or Modification of Habitat:

* disruption and destruction of hammock habitat

Predation and/or Destruction:

* widespread aerial application of insecticides by the Monroe County Mosquito Control District
* overcollecting
* natural factors (weather, predation/parasitism, etc.)

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Schaus' swallowtail butterfly and to protect its habitat include:

* direction of growth away from hammocks known to be habitat for the Schaus' swallowtail butterfly
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality upland vegetation communities and habitat of threatened and endangered species
* coordination with the Monroe County Mosquito Control District to promote continued conformance with aerial insecticide spraying guidelines for avoiding Schaus' swallowtail butterfly habitat on North Key Largo
* promotion of research and development of mosquito control methods which are an alternative to aerial spraying
* encouragement of planting of torchwood (Amyris elemifera) within the range of the Schaus' swallowtail habitat on North Key Largo
* requirement for revegetation of construction sites on North Key Largo, in part, with torchwood (Amyris elemifera)
* requirement for tree replacements for sites on North Key Largo to include torchwood (Amyris elemifera)
* monitoring of FKAA restrictions of water supply hook-ups in Schaus' swallowtail butterfly habitat

More specifically, the Permit Allocation and Point System of the Comprehensive Plan should consider assignment of a negative point rating to developments proposed within hammocks documented as habitat of the Schaus' swallowtail butterfly. These areas shall be identified by the Monroe County Biologist in cooperation with FWS and FGFWFC.

3.13.20 Stock Island Tree Snail (Orthalicus reses)

A. Status, Distribution and Habitat Description

The Stock Island tree snail is an endemic tree snail that is found only in remnant hammocks around the Municipal Golf Course on Stock Island (Deisler, 1982).

The Stock Island tree snail is found only in tropical hardwood hammocks. It feed on algae and lichens on the trunks and limbs of native and non-native trees in hammocks. Foraging occurs at night during the rainy season from June through December (U.S.FWS, 1982c). During other times of year it is in aestivation, attached to trees by a hard mucous seal. The snails are hermaphroditic but crossbreeding between individuals is required for successful reproduction. The snails do not reproduce until 2 to 3 years of age, eggs are laid in cavities burrowed at the base of trees.

Population estimates in 1982 ranged from 200 to 800 (U.S.FWS,1982c). The population presently appears to be in decline with estimates of fewer than 100 individuals remaining (Monroe County Biologist, personal communication, December 1991).

B. Reasons for Decline and Recovery Activities for the Stock Island Tree Snail

Several factors have contributed to the decline in populations of the Stock Island tree snail (U.S.FWS, 1982c). These are summarized as follows:

Destruction or Modification of Habitat:

* disruption and destruction of hammock habitat

Predation and/or Destruction:

* widespread aerial application of insecticides by the Monroe County Mosquito Control District
* overcollecting
* natural factors (weather, Predation/parasitism, etc.)

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Stock Island tree snail and to protect its habitat include:

* continuing to provide U.S.FWS with periodic population counts
* coordination with the U.S. FWS regarding introduction of Stock Island tree snails to other locations (probably offshore islands) in the Keys
* acquisition of identified introduction sites by the County or support for acquisition of these sites by state, federal, and/or non-profit conservation organizations
* coordination with the Monroe County Mosquito Control District to eliminate aerial insecticide spraying in the habitat area of the Stock Island tree snail
* promotion of research and development of mosquito control methods which are an alternative to aerial spraying

3.13.21 Key Tree-Cactus (Cereus robinii)

A. Status, Distribution and Habitat Description

The Key tree-cactus (Cereus robinii) is the largest native Florida cactus. It is found in rocky tropical hammocks.

The Key tree-cactus is restricted in range to the Florida Keys and Cuba (U.S. FWS, 1986a). Once locally abundant, it has largely disappeared from the Keys. Today, there are five remaining populations, including one on Upper Matecumbe Key, two on Long Key, and two on Big Pine Key (U.S.FWS, 1986a). Of these, three are in private ownership and two are in public ownership, including one in the National Key Deer Refuge and the other in Long Key State Recreation Area (U.S.FWS, 1986a).

B. Reasons for Decline and Recovery Activities for the Key Tree-Cactus

Several factors have contributed to the decline in populations of the Key tree-cactus (U.S.FWS, 1986a). These are summarized as follows:

* disruption and destruction of hardwood hammocks
* hurricanes
* fires
* overcollection.

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the key tree-cactus and to protect its habitat include:

* coordination with FWS to identify:
  - the three Key tree-cactus sites which remain in private ownership on Big Pine Key, Long Key and Upper Matecumbe Key
  - potential introduction sites for the Key tree-cactus in the Keys
* county acquisition of the sites remaining in private ownership as well as acquisition of potential introduction sites (or support for acquisition of these sites by state and/or non-profit conservation organizations)
* prohibition of disturbance to the Key tree-cactus during the land development process
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality tropical hardwood hammocks, especially when they include Key tree-cactus.

3.13.22 Small's Milkpea (Galactia smallii)

A. Status, Distribution and Habitat Description

Small's milkpea (Galactia smallii) is an endemic plant restricted to areas of the south Florida peninsula. It occurs in pine rockland habitat. The reduction of this habitat type in south Florida and the Keys, combined with the exclusion of fire, has caused many species characteristic of pine rocklands, such as Small's milkpea, to be threatened with extinction (U.S.FWS, 1988b).

Small's milkpea is currently known from two sites in the Perrine area and from four sites near the Homestead area (U.S.FWS, 1988b). The historic range of the species is unknown, but may have extended into the Keys.

B. Reasons for Decline and Recovery Activities for Small's Milkpea

Small's milkpea has declined due to disruption and destruction of rockland habitat combined with the exclusion of fire from these habitats (U.S.FWS, 1986a).

Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Small's milkpea and to protect its habitat include:

* coordination with FWS to identify:

  - sites of Small's milkpea which may occur in the Keys
  - potential introduction sites for Small's milkpea in the Keys
* county acquisition of Small's milkpea sites remaining in private ownership as well as acquisition of potential introduction sites (or support for acquisition of these sites by state and/or non-profit conservation organizations)
* prohibition of disturbance to the Small's milkpea during the land development process
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality native upland vegetation, especially when they include Small's milkpea.

3.13.23 Garber's Spurge (Euphorbia garberi)

A. Status, Distribution and Habitat Description

Garber's spurge (Galactia smallii) is an endemic plant restricted to areas of the south Florida peninsula. Garber's spurge occurs in transitional areas between hardwood hammocks and pine rocklands, and on beach ridges in saline coastal areas (U.S. FWS, 1988b). While Garber's spurge formerly occurred in such habitats throughout Dade and Monroe Counties, including the Keys, the plant is now known only from four sites in Everglades National Park and one site in the Keys (U.S.FWS, 1988b).

B. Reasons for Decline and Recovery Activities for Garber's Spurge

Garber's spurge has declined due to disruption and destruction of habitat (U.S.FWS, 1988b). Recovery activities which could be implemented by Monroe County to prohibit the destruction of the Garber's spurge and to protect its habitat include:

* coordination with FWS to identify:
  - sites of Garber's spurge which may occur in the Keys
  - potential introduction sites for Garber's spurge in the Keys
* county acquisition of Garber's spurge sites remaining in private ownership as well as acquisition of potential introduction sites (or support for acquisition of these sites by state and/or non-profit conservation organizations)
* prohibition of disturbance to Garber's spurge during the land development process
* revisions to the Habitat Evaluation Index in the Land Development Regulations (Monroe County BOCC, 1990) which will better protect high quality native upland vegetation, especially when they include Garber's spurge.

3.14 Fisheries

3.14.1 Fisheries of the Florida Keys

A. Fish Species Common to Mangrove Communities

Many species of fish complete their life cycle within the mangrove community. Others are dependent upon mangroves during juvenile states and migrate to grassbeds and/or coral reefs when mature. Others are seasonally or locally abundant. Many of the invertebrates and fishes are